NAVSHIPS 0967-057-7010

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TECHNICAL MANUAL

for

RADIO RECEIVING SET AN/SRN-12 (XN-1)

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

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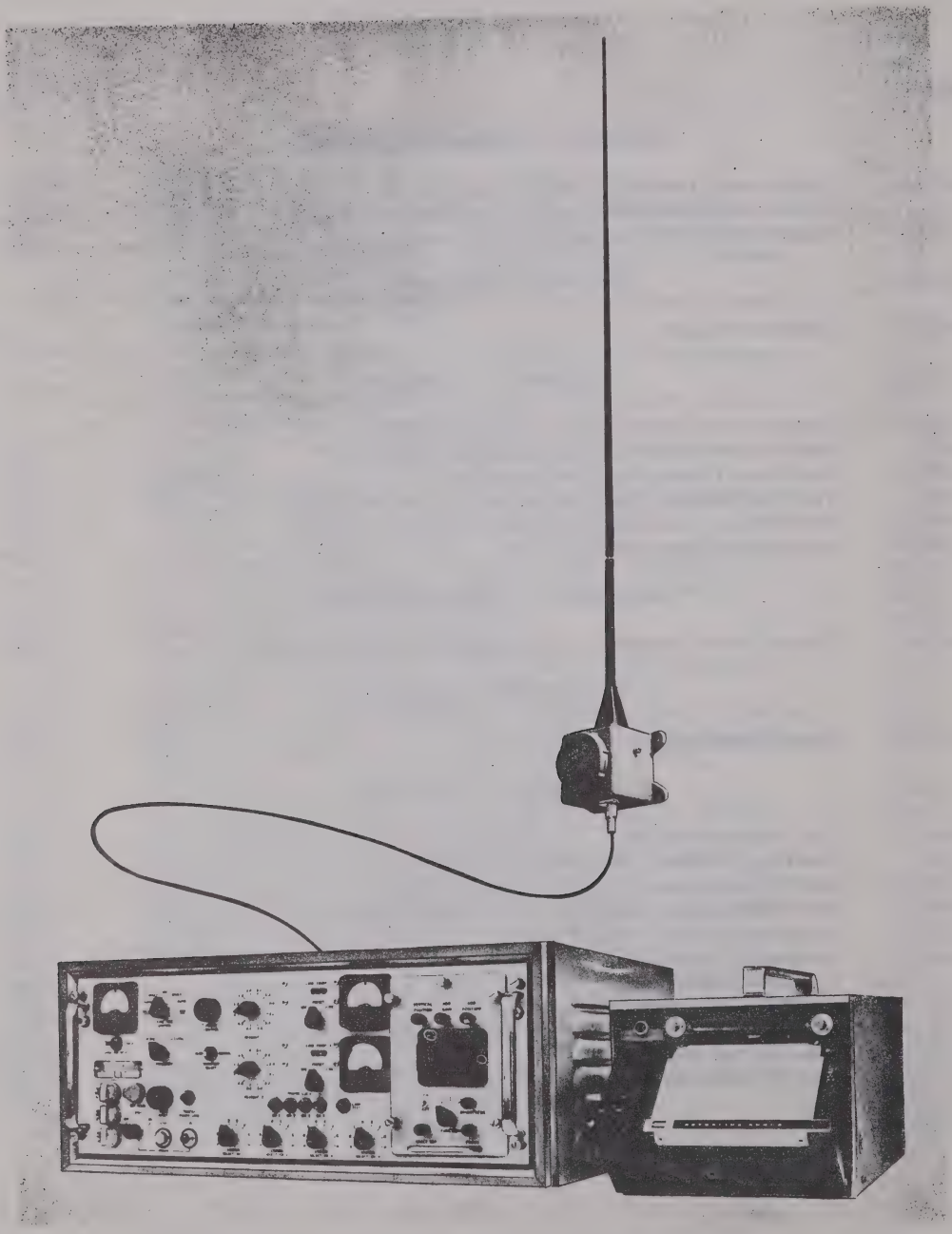

Figure 1-0. Omega Navigation Receiving Set, Pictorial View

SECTION 1
GENERAL INFORMATION

1-1. SCOPE

This Technical Manual is in effect upon receipt. Extracts from this publication may be made to facilitate the preparation of other Department of Defense publications.

This Technical Manual contains instructions for the installation, operation, troubleshooting, and maintenance of the Omega Navigation Receiving Set. In addition to these instructions, there is also a section which covers a list of reference designations, a list of units, and an identification table of parts.

1-2. GENERAL DESCRIPTION

The Omega Navigation Receiving Set consists basically of a whip antenna, a coupler, and a solid-state, two frequency, four channel superheterodyne, sampled data phase lock receiver system for reception of Omega navigation signals, and of tuning, phase measuring, and display equipment for determining position. (See figure 1-1.)

The Omega system of navigation is based on the principle that the velocity of propagation of electromagnetic radiation is constant. This means that the difference in distance from a receiving station to two synchronized transmitting stations, transmitting at the same frequency, is indicated by the difference in the phase of the signals received. At the operating frequencies of the Omega system, the signal from the more distant station is received later than the signal from the closer station. The difference may be a portion of a wavelength or many wavelengths, depending upon the relative distance between the receiver and each transmitter.

If a series of measurements is taken (and plotted) at a number of points while maintaining the difference in distance between the receiver and transmitter, a hyperbola is described, the ends of which curve toward the closer transmitter. (See figure 1-2.) This line is called a line of position. Other lines, similar to this line, are formed when other distances are used. Thus, a receiver measuring the difference in distance between two transmitting stations can be placed somewhere on a particular line of position between the transmitters.

If a third transmitter, located at another position, is used in conjunction with one of the first two transmitters, a new series of lines of position is formed. The two groups of lines of position cross each other; hence, when the receiver is located in a particular line of position using each set of transmitters, it must be precisely fixed at the intersection of the two lines. (See figure 1-3.) Also, a fourth transmitter used in addition to the others forms two independent pairs, each having its own lines of position.

There is an infinite number of hyperbolic lines of position (each representing a phase difference between signals) between any two transmitting stations. With the transmitting stations fixed at a precise geographic location and all transmitted signals accurately phase synchronized, the hyperbolic lines of position formed between each pair of stations are also fixed and precisely located. A representative quantity of these lines can thus be inscribed on navigational charts.

In the Omega system, three or more radio transmitting stations are utilized. These stations transmit in sequence (time-sharing) at a single common frequency. Synchronization is maintained by the accuracy of each station's independent control reference. Each station employs a timer (commutator or sequence programmer) to control the time and duration of transmission and switching functions.

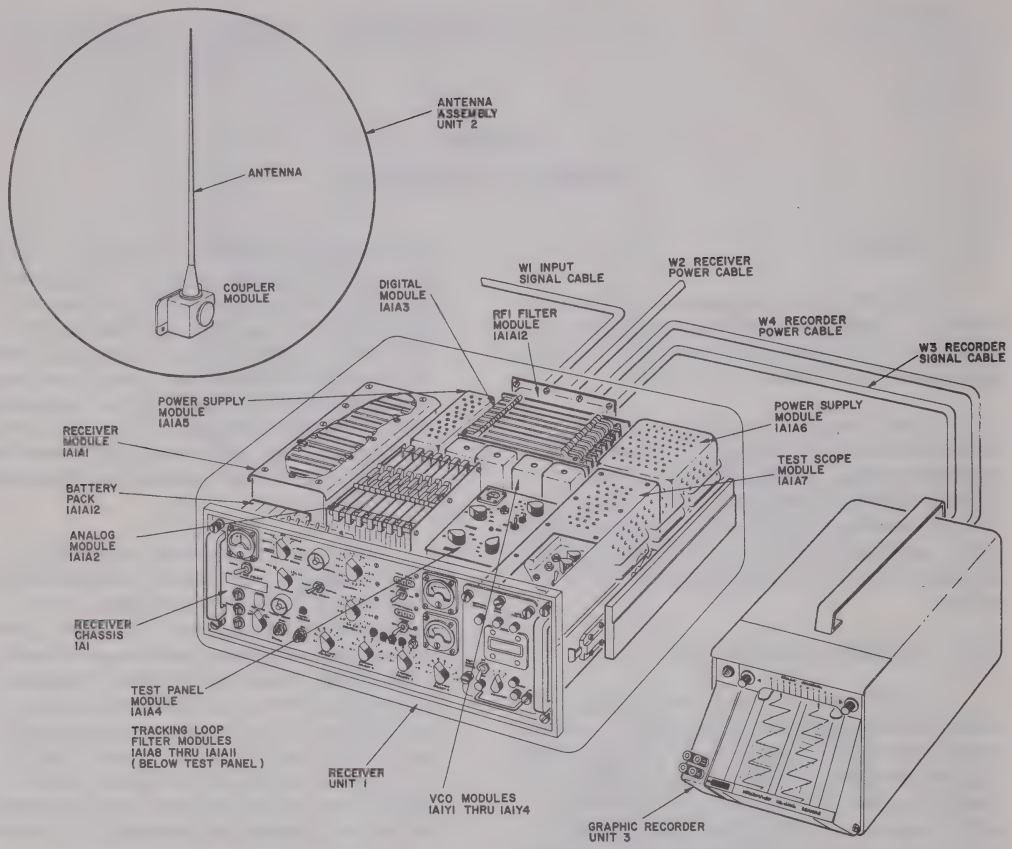

Figure 1-1. Omega Navigation Receiving Set

The basic period for one cycle of sequential transmissions is 10 seconds with a space interval of 0.2 second between each transmission. Figure 1-4 shows a transmission sequence accommodating a network of eight stations. The transmission pattern shown is for 10.2 kc. The pattern for 13.6 kc is time-slipped so that Station A transmits on 13.6 kc while Station B is on 10 kc and so on. For experimental purposes, a five-second, four-station transmission cycle, identical to the first five seconds of the figure, may also be used. The identification of a particular signal with a specific transmitter is accomplished by observing the time duration of the signal and its position relative to other received signals.

The Omega Navigation Receiving Set operates on carrier frequencies of either 10.2 kc or 13.6 kc. It can process input signals plus noise within the range of 5 to 500,000 microvolts with the differential phase error not exceeding 3.60 degrees for any 40 db segment of the 5 to 500,000 microvolt range. Four channels are used to provide two intersecting families of lines of position.

A timing pattern, identical to the received signal pattern, is generated in the commutator to provide a means of synchronizing the receiver with the received signals. The synthesized and received patterns are aligned manually and are displayed on the oscilloscope, the chart recorder, and the two

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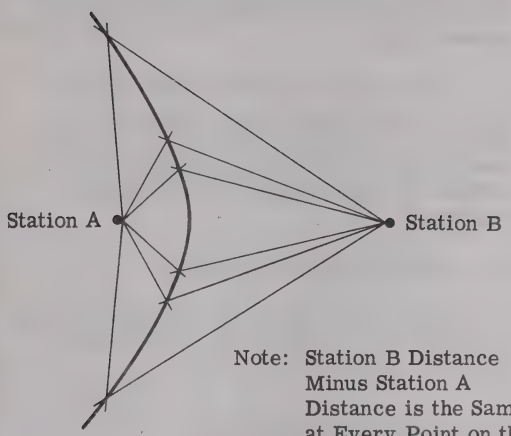


Figure 1-2. Hyperbolic Line of Position

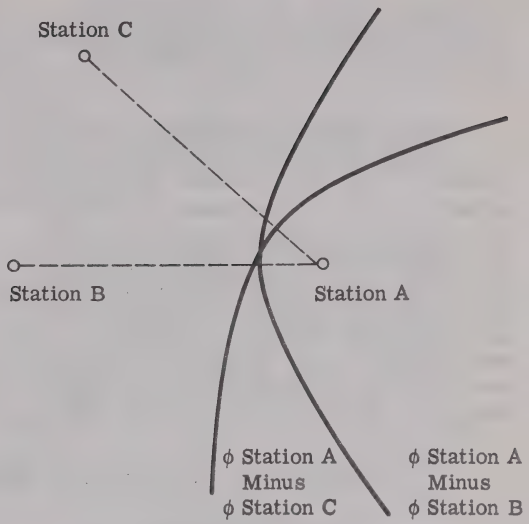


Figure 1-3. Intersection of Hyperbolic Line of Position

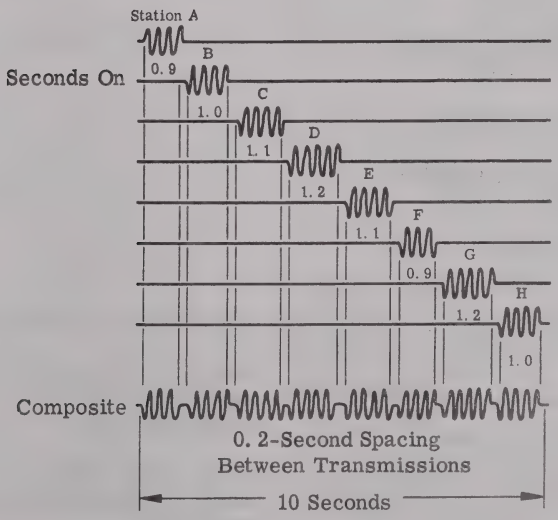


Figure 1-4. Transmission Schedule for Eight Omega Navigation Transmitters

front panel meters. A possible alternate method is to bring the synthesized pattern to synchronization by the use of WWV transmissions.

Phase difference information is displayed on two front panel meters and a chart recorder. Each cycle (or lane) is registered on the front panel bidirectional lane counters. Each counter and associated meter (divided into hundredths of a lane) represents one line of position. As a ship travels through the Omega lanes the chart recorder will show a sawtooth pattern wherein one "tooth" represents one full lane. In figures 1-2 and 1-3 are seen some hyperbolic lines of position along which the difference in distance (and phase) to two stations is constant. It will be seen that crossing lines of position, of which there are an infinite number, will result in phase change.

The Omega Navigation Receiving Set also features a built-in test system which allows fault isolation to the board level, as well as operational testing and alignment without the need of special external test equipment.

1-3. DESCRIPTION OF UNITS

A complete Omega Navigation Receiving Set consists of the following units listed in Table 1. (Figure 1-1.)

TABLE 1-1. COMPONENTS, OMEGA NAVIGATION RECEIVING SET

NOMENCLATURE	FUNCTION
Receiver, Unit 1 Receiver Chassis 1A1 Receiver Module 1A1A1 Power Supply Module 1A1A5 Digital Module 1A1A3 RFI Filter Module 1A2 Power Supply Module 1A1A6 Test Oscilloscope Module 1A1A7 VCO Modules 1A1Y1, 1A1Y2, 1A1Y3, 1A1Y4 Tracking Loop Filter Modules 1A1A8, 1A1A9, 1A1A10, 1A1A11 Analog Module 1A1A2 Battery Pack 1A1A12	Receives Omega Navigation signals, processes these signals, stores phases, makes the difference computations and displays the results.
Antenna Assembly, Unit 2 Antenna Coupler Module	Picks up the Omega Navigation signals and provides the required matching impedance to properly transfer these signals to the receiver via the RF transmission line.
Graphic Recorder, Unit 3	A dual channel display unit for presenting Omega Navigation lines of position graphically.

The following paragraphs contain a description of the units comprising the Omega Navigation Receiving Set.

1-3-1. RECEIVER, UNIT 1

The Omega Receiver houses and interconnects the major electronic components of the Omega system, with the exception of the graphic recorder and the antenna assembly (see figure 1-1). The components are mounted on the receiver chassis which is fitted with quick-disconnect pivot slides to facilitate removing the chassis from the cabinet or locking the chassis in either a horizontal or a vertical position. The front panel of the receiver chassis is equipped with controls, switches, and indicators to aid the operator in fulfilling the overall function of the Omega Navigation Receiving Set.

Louvers are provided on both sides and the back of the receiver cabinet to allow the passage of cooling air through the receiver. A connector panel located at the rear of the cabinet provides power and signal distribution.

The receiver is composed of the following subassemblies:

1-3-1-1. Receiver Module. The receiver module (figure 1-1) is comprised of eight printed circuit cards mounted in an rf shielded enclosure of compartmented construction. These printed-circuit cards contain the receiver rf and if circuitry. The construction methods and access covers (top and bottom) are fastened and sealed in a manner to hold degradation due to electromagnetic radiation to a minimum.

1-3-1-2. Analog Module. The analog module (figure 1-1) is composed of 12 printed circuit cards mounted in printed circuit card holders. Ten of these printed-circuit cards contain analog circuits used in the receiver; one card is used as an extender card for testing and one as a spare card storage position. Any printed circuit card is easily removed by disengaging the proper cam lock and lifting up the desired card.

1-3-1-3. Digital Module. The digital module (figure 1-1) is composed of a printed circuit card rack and eight printed circuit cards containing digital integrated and discrete component circuits used in the receiver. By disengaging the proper cam lock and lifting the designated card, a printed-circuit card is easily removed.

1-3-1-4. Power Modules. Two power modules (figure 1-1) provide power for the Omega Navigation Receiving Set. One power supply (figure 1-1) supplies the oscillator and timer circuits and the battery charger. The battery charger provides a charging rate of 60 ma for 14 to 16 hours for the charge restoration of the battery pack. It maintains a trickle charge rate of 6 ma to maintain the batteries during long periods of nonuse. (See paragraph 1-3-1-10.) The other power supply provides power for the remainder of the circuitry. These power supplies may be operated at 105, 115, or 125 volts ac (± 10%) at 60 cps (± 3 cps) by selection of the proper tap at the input transformer. Each power supply requires a maximum power input of 100 watts. The power supplies will operate at temperatures approaching 65°C; they utilize the principles of natural cooling to remain within their operating temperature range.

1-3-1-5. Test Panel. The test panel (figure 1-1) contains switches, controls, and a test meter necessary to isolate malfunctions in the receiver to a small group of printed circuit cards. Fault isolation techniques are then used to determine the faulty card.

1-3-1-6. Auxiliary Panel. The auxiliary panel (figure 1-1) is composed of a group of switches and secondary controls utilized to augment the operating and testing functions of the receiver.

1-3-1-7. Tracking Loop Filter Modules. Four tracking loop filters (figure 1-1) sample the incoming data, store the phases, adjust the VCO's in phase lock with the four selected Omega transmissions. Each tracking loop filter is composed of a sampling relay followed by an operational amplifier sample-hold integrating circuit contained in

a separate encapsulated interchangeable assembly.

Each tracking loop filter requires 15 volts ± .75 volt dc at a current of not more than 18 ma. The output control voltage to the VCO's is ± 4 volts.

1-3-1-8. Voltage-Controlled Oscillator Modules. Four voltage-controlled oscillator modules (figure 1-1) utilize highly stable crystal elements to maintain the rest frequency to a stability of one part in 10^7. The rest frequency is 816,000 cps ± 1 cps. Each voltage-controlled oscillator is enclosed in a container which is approximately 5 inches high by 2 inches wide by 2 inches deep. Tuning adjustment may be made by means of a slug at the top of each container. Each voltage-controlled oscillator required ± 4 volts dc excursion at the modulation terminal for proper operation of the tracking loop. It produces an output voltage in the form of a square wave of 5 volts ± 0.5 volt peak-to-peak.

1-3-1-9. RF Interference Filter Modules. Four rf interference filters of two different types are contained in a container (figure 1-1). These filters reduce external line conducted fields from electronic equipment in a shipboard environment. One type of filter operates at 125 volts ac at 3 amps; it is a low-pass filter operating at 0-400 cps with a minimum attenuation of 40 db at 15 kc. The other type of filter operates at ± 15 volts dc at a maximum current drain of 20 ma. It is also a low-pass filter operating at 0-100 cps with a minimum attenuation of 40 db at 15 kc.

1-3-1-10. Battery Pack. A battery pack (figure 1-1) is provided for intermittent emergency power. It is capable of supplying power for the VCO's and timing circuitry during a 5 minute lapse of prime power. It is composed of a group of nickel cadmium batteries sufficient to supply 28 volts dc. Each individual cell provides 1.2 volts dc. The batteries are enclosed in a case 3-1/2 inches high by 3-1/2 inches wide by 2-1/4 inches deep; the cover may be removed for replacing batteries when they are no longer able to be recharged.

The Power Supply provides a 6 ma trickle charge maintaining general battery condition. A High Charge switch increases charging rate (60 ma) when needed, but should be turned off when a final voltage of 1.45 - 1.5 volt per cell is reached or after 14 - 16 hours of charging has occurred.

WARNING

There is no visual reminder to return the High Charge switch to trickle charge when necessary, so the operator must take responsibility for this.

1-3-1-11. Test Scope Module. For ease in aligning, synchronizing, and servicing the receiver, a test scope (figure 1-1) is contained within the receiver unit. Five captive screws hold the test scope within the receiver chassis; it may be removed without removing the receiver chassis from the cabinet.

Common controls and switches are found on the front panel of the test scope. Secondary controls and switches are mounted on an internal shelf on the test scope. The electronic circuitry, including the required power, is provided on eight circuit cards (six printed circuit and two component cards) located in a scope assembly. The cathode ray tube is a direct-viewed, rectangular type, measuring 3 inches across and 1 inch high. The test scope is provided with a signal probe and a sync probe for temporary connection of the internal test points to the scope vertical amplifier, together with the appropriate horizontal sweep trigger signals necessary for convenient viewing. The probes are stored in the receiver. Three sweep speeds are provided: 10 microseconds, 125 microseconds, 5 seconds left to right, and 5 seconds right to left.

1-3-2. ANTENNA ASSEMBLY, UNIT 2

The antenna assembly (insert, figure 1-1) is composed of the antenna and the antenna coupler.

The antenna is a 10-foot whip including the height of the base. It is composed of a phosphor bronze conductor 1/8-inch in diameter encased in a fiberglass cover. It has approximately 25 picofarads of capacity vertically over a ground plane.

The antenna is self-supporting and is designed to withstand wind velocities up to 1000 knots. It will remain erect within 15° of vertical for winds up to 30 knots, and not more than 45° from the vertical for winds up to 60 knots.

The coupler connects the antenna to the receiver through a standard 95-ohm balanced line. It couples signals at frequencies of 10.2 kc and 13.6 kc to the receiver, and at the same time rejects other frequencies. The coupler is mounted in a special housing at the base of the antenna.

1-3-3. GRAPHIC RECORDER, UNIT 3

The graphic recorder is a commercial unit manufactured by Esterline-Angus. It is Model S602R, a rectilinear, dual-track unit. A galvanometer movement drives marking pens, while the chart speed is controlled by a mechanical gearing arrangement. Refer to the manual provided with this volume for a complete description, operation, theory, and maintenance of the graphic recorder.

1-4. REFERENCE DATA

a. Operating Frequency: 10.2 or 13.6 kc.

b. Type of Reception: Omega 5 or 10 second patterns; sampled data phase locked loop.

c. Bandwidth: RF - 1 kc, IF - 100 cps.

d. Receiver Noise: 1.5 microvolts referenced to a 100 cps bandwidth.

e. Receiver Type: Superheterodyne, 17 kc intermediate frequency.

f. Input Signal-to-Noise Ratio: -20 db referenced to a 100 cps bandwidth.

g. Receiver Gain: Approximately 145 db with hard limiting of 20 db on a 20 microvolt signal into a dummy antenna (10 foot whip equivalent).

h. Dynamic Range: 5 to 500,000 microvolts.

i. Image Rejection: 100 db

j. Suppression of Interfering Signals: 17 kc signal suppressed 80 db down.

k. Accuracy: Differential phase error less than four degrees over any 40 db portion of dynamic range.

l. VCO Frequency: 816,000 cps.

m. Timing Clock Frequency: 17,000 cps.

n. Local Oscillator Frequency: 10.2 kc - 27.2 kc, 13.6 kc - 30.6 kc.

o. Primary Power Source: 115 volts, 60 cps, single phase, 360 watts.

p. Operating Temperature Range: 0 to 50°C.

1.5 EQUIPMENT SUPPLIED

TABLE 1-2. OMEGA NAVIGATION RECEIVING SET EQUIPMENT SUPPLIED

Qty/Equip.	Nomenclature Name	Designation	Dimensions (In.) Height	Width	Depth	Vol.	Wgt.
1	Receiver	Unit 1	11-1/8	26-11/16	22-5/8	3.5	125
1	Antenna Assembly						
	Coupler	Unit 2	6-7/8	10	7-1/4		
	Antenna	Unit 2	120				1.7
1	Graphic Recorder	Unit 3	10	10	19-1/2	1.12	36
1	Graphic Display Kit						
1	Recorder Instr. Manual						
1	Tech. Manual for NAVSHIPS 0967-057-7010						
1	Tool, adjustment, p/n 39406-1						
1	Power Input Connector PTOGE-5SY(SR)						
1	Aux. Sig. Generator PTOGE-14-5PW(SR)						
1	Mating Connector UG421J						
4	Spacer p/n B39387						

1.6 EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

TABLE 1-3. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

Qty/Equip.	Name Nomenclature	Designation	Required Use	Omega Receiver Equipment Characteristics
1	Headphones		Synchronization	200 ohm impedance (minimum)

1-7. FACTORY OR FIELD CHANGES

No factory or field changes have been made for this equipment. Refer to NAVSHIPS 900,000, Electronics Installation and Maintenance Book (EIMB) for the complete field change identification guide index.

SECTION 2
INSTALLATION

2-1. GENERAL

The Omega Navigation Receiver Set is installed by trained personnel in accordance with the installation drawings, figures 2-1 and 2-2. Each installation will vary to conform to the available space and configuration of the individual ship.

Included in this section are instructions for unpacking and handling, power requirements, installation requirements, cable assemblies, and inspection and adjustment.

2-2. UNPACKING AND HANDLING

All components of the Omega Navigation Receiver Set are packaged according to standard practices. Care and good judgment should be exercised when opening all packing cases to preclude damage or loss of their contents.

Uncrated weights and dimensions of all components of the Omega Navigation System are listed in Table 1-2.

2-3. POWER REQUIREMENTS

The Omega Navigation Receiving Set requires 115 volts ac, 60 cps, single phase, with a power requirement of 360 watts (maximum).

2-4. INSTALLATION REQUIREMENTS

There are no fixed requirements for the selection of a site for the Omega Navigation Receiving Set. Normally, the receiver and graphic recorder are installed in the radio room on a bench top or table in accordance with the installation drawings.

The antenna and antenna coupler are usually mounted high on the foremast and should be located within 300 cable feet of the receiver-indicator unit.

The applicable installation and outline drawings for the Omega Navigation Receiving Set are contained at the end of this section.

2-5. CABLE ASSEMBLIES

Table 2-1 contains a list of all of the interconnecting cables between the units of the Omega Navigation System. Included in the table are a list of the Nortronics, as well as Government, furnished cables.

2-6. INSPECTION AND ADJUSTMENT

Prior to the application of power to the Omega Navigation Receiver, inspect the units for physical damage, including broken front panel controls and indicators, or broken or disconnected wires. Ensure that all printed circuit cards and cable connectors are properly sealed in their receptacles.

Energize the receiver as follows:

NOTE

During this procedure, check for signs of overheating, burning insulation, and other physical indications of malfunction. If such malfunctions do exist, isolate and correct the trouble before proceeding.

1. Place OFF/STANDBY/ON switch (figure 3-1) to ON.

2. Ensure that ON lamp is illuminated.

3. Allow the equipment to reach operating temperature.

4. Complete the self test procedures in section 4.

5. Perform the operating procedures outlined in section 3 to ensure that the equipment is operating correctly.

6. De-energize the receiver by placing the OFF/STANDBY/ON switch to the OFF position.

TABLE 2-1. CABLE ASSEMBLIES

Unit 1	Unit 1 Jack No.	Unit 1 Recept. MS No.	Cable Conn. at Unit 1 MS No.	Cable Type	Cable Function and Reference Designation	Cable Conn. at Unit 2 MS No.	Unit 2 Recept. MS No.	Unit 2 Jack No.	Destination
Receiver	J1	3114E-14-5PY	3116E-14-5SY (SR)	Govt. Furnished	Receiver Power W2				60 cps Line
Receiver	J2	3114E-14-5SZ	3116E-14-5PZ (SR)		Recorder Power W4				Graphic Recorder
Receiver	J3	3114E-14-5SY	3116E-14-5PY (SR)	(300 ft.)	Recorder Signal W3				Graphic Recorder
Receiver	J4 (Aux.)	3114E-14-5SW	3116E-14-5PW (SR)		Auxiliary Signal				Signal Utilization
Receiver	J5	74868 UG423U	UG544/U	RG111 A/U G.F.	Input Signal W1	UG421B/U	74868-UG423U	-	Ant. Assy

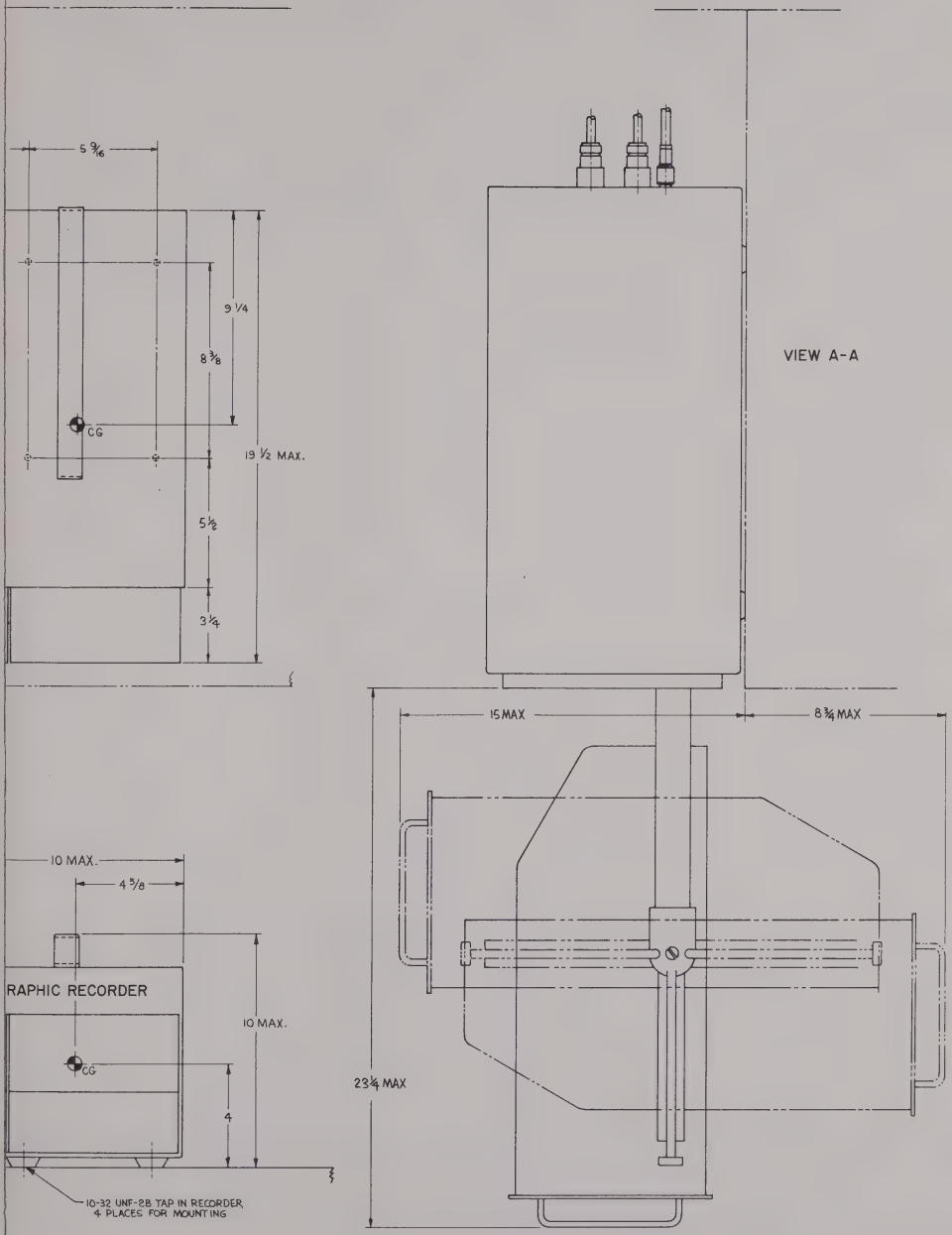
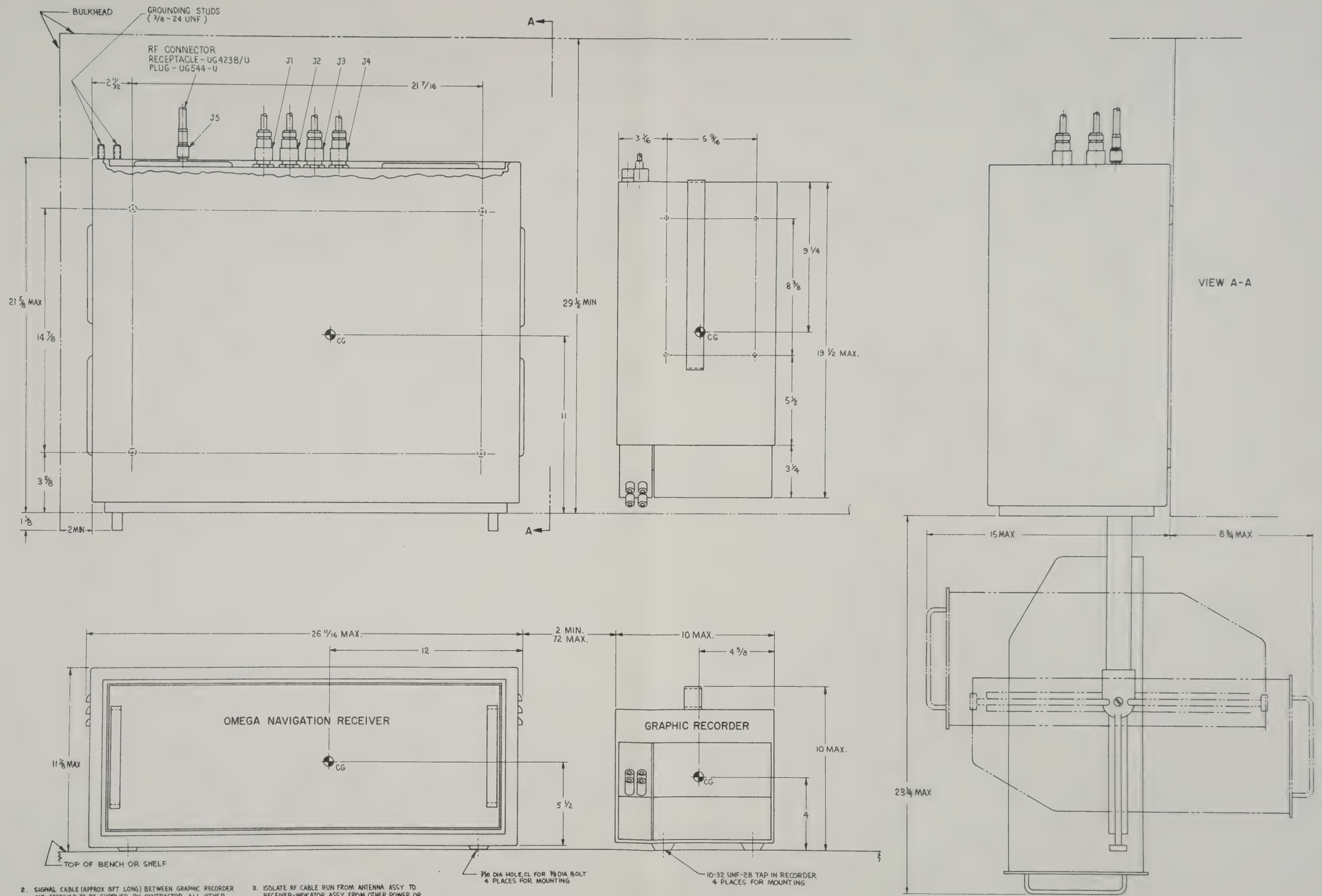


Figure 2-1. Omega Navigation Receiver Installation



2. SIGNAL CABLE (APPROX 8FT LONG) BETWEEN GRAPHIC RECORDER AND RECEIVER TO BE SUPPLIED BY CONTRACTOR. ALL OTHER CABLES TO BE SUPPLIED BY GOVT.
1. INPUT POWER TO BE 115V, 1 PHASE, 60 CPS 3.04 AMPS

3. ISOLATE RF CABLE RUN FROM ANTENNA ASSY TO RECEIVER-INDICATOR ASSY FROM OTHER POWER OR SIGNAL CABLES WITHIN THE SHIPS DISTRIBUTION SYSTEM CAPABLE OF EMITTING INTERFERING SIGNALS IN THE 8-15KC FREQ RANGE

Figure 2-1. Omega Navigation Receiver Installation

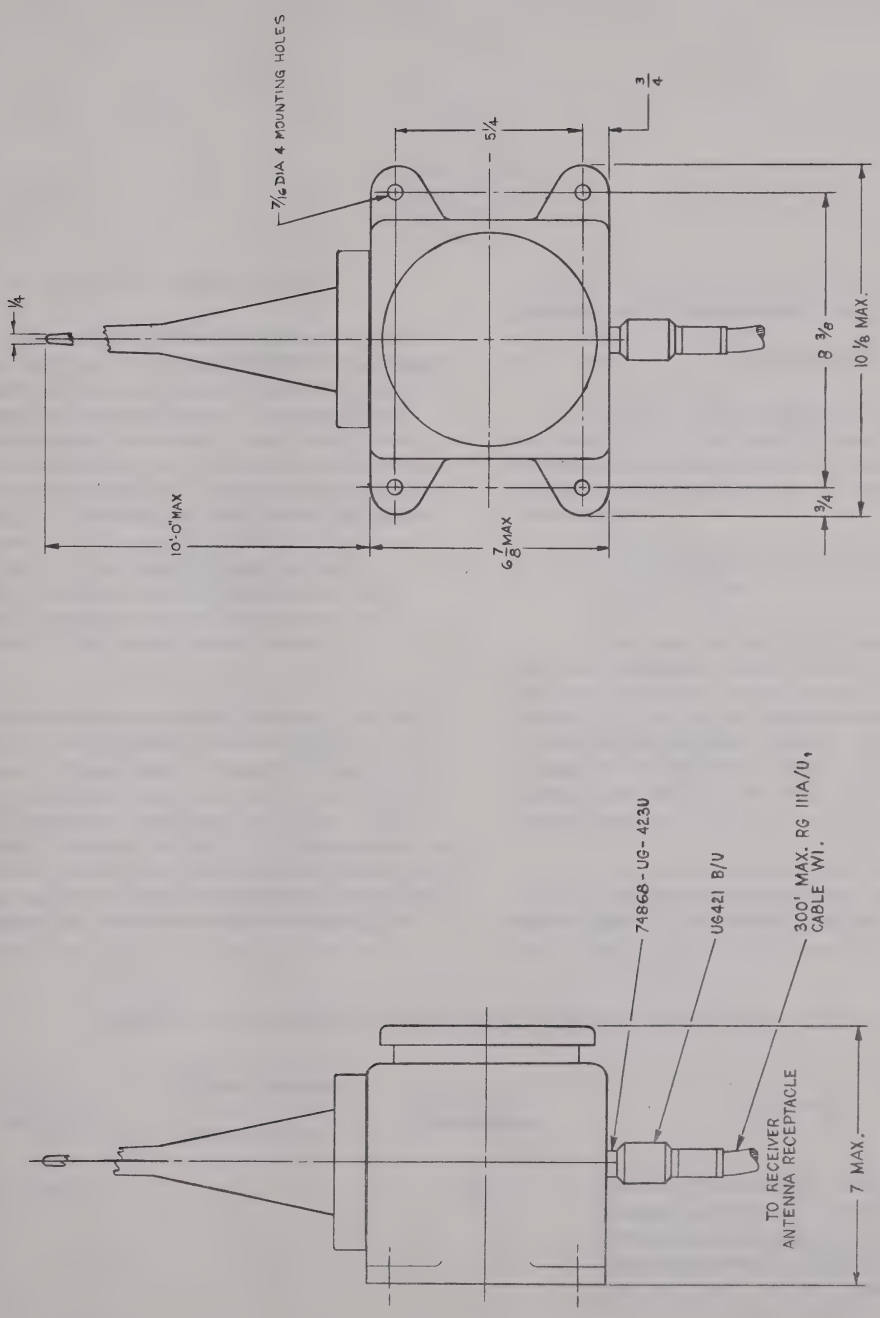


Figure 2-2. Omega Navigation Receiving Set Antenna Installation

SECTION 3
OPERATION

3-1. FUNCTIONAL OPERATION

Omega Navigation Receiving Set is a relatively small, compact receiver, designed to operate with the signals generated by the Omega Navigation System. The equipment measures and indicates a phase difference between selected pairs of signals from Omega transmitting stations. The difference information is presented on front panel indicators in number of lanes and percent of one lane, and/or on a two channel chart recorder. Using Omega Navigation charts, this difference information is interpreted to fix the location of the receiving equipment.

It is necessary to determine initially the receiver location to within one lane: for example, it is necessary to know the lane of position to within plus or minus four nautical miles if the receiver is located on a base line and the carrier frequency is 10.2 kc. For a carrier frequency of 13.6 kc it is necessary to know the line of position to within plus or minus three nautical miles under similar conditions. However, once the receiver is tracking its transmitting stations, phase difference readouts are continuous, and the receiver position may be determined at any time.

3-2. OPERATING PROCEDURES

The following paragraphs contain a description of all the controls and indicators associated with the Omega Navigation Receiving Set and instructions for operating the receiving set.

3-2-1. DESCRIPTION OF CONTROLS AND INDICATORS

The controls and indicators associated with the operation and test of the receiving set are located on five control panels. Tables 3-1 through 3-5 list all the controls and indicators as well as the function of each. Figures 3-1 through 3-5 indicate the location of each control and indicator on each of the five control panels.

The location and function of the controls and indicators on the Graphic Recorder control panel are included in the manufacturer's manual provided with this manual.

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
SYNC Meter	1	M3	Indicates whether or not the internal timing network is in synchronization with the station pattern. Used in conjunction with: SYNC IND SELECT (29), SYNC TIME CONTROL (3), and PULSE CONTROL (5).

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
FREQUENCY Selector Switch	2	S13	Provides selection of receiver set operating frequency and automatically aligns the receiver strip filters for operation at the selected frequency.
SYNC TIME CONTROL Selector Switch	3	S12	Used in conjunction with SYNC Meter (1), SYNC IND SELECT (29), and PULSE CONTROL (5) to advance or retard the internal timing network to bring it into synchronization with the station pattern. To advance the timing network, the switch is placed in the ADD direction to either the SINGLE or RAPID position. To retard the timing network, the switch is placed in the DELETE direction to either the SINGLE or RAPID position. In either direction the SINGLE position will either advance or retard the timer pulse pattern by 10 milliseconds each time the PULSE CONTROL (5) is depressed. In either direction the RAPID position will either advance or retard the timer pulse pattern at a rate of 10 milliseconds per 1.25 seconds thus enabling a larger correction in a short period. The OFF position is the normal operating position when time synchronization is achieved.
RECORDER SELECT Toggle Switch	4	S11	Used to transfer the selected information to the Graphic Recorder for recording and display. In the NORMAL position the percent of lane signal for each lane is transmitted to the recorder provided the TIMER TEST Selector Switch on the Test Panel is in the NORMAL position. When the TIMER TEST Selector Switch is in any position other than NORMAL and the RECORDER SELECT Toggle Switch is in the NORMAL position either one of the four long station gates, one of the four short station gates, or one

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
RECORDER SELECT Toggle Switch (continued)			of the four sync gates will be transferred to one channel of the recorder and the timing network generated reference pulse will be transferred to one channel of the recorder. When the RECORDER SELECT Toggle Switch is in the ALIGN position the detected envelope will be transmitted to one channel of the recorder and the timing network generated reference pulse will be transmitted to one channel of the recorder provided the TIMER TEST Selector Switch on the Test Panel is in the NORMAL position. When the TIMER TEST Selector Switch is in any position other than NORMAL and the RECORDER SELECT Toggle Switch is in the ALIGN position any one of the twelve gates will be transmitted to one channel of the recorder and the reference pulse will be transmitted to one channel of the recorder.
PULSE CONTROL Pushbutton	5	S10	Used in conjunction with the SYNC Meter (1), SYNC TIME CONTROL Selector Switch (3), and SYNC IND SELECT Toggle Switch (29). When depressed, provides pulses for advancing or retarding the timing network to bring it into synchronization with the station pattern.
READOUT 2 Selector Switch	6	S8	In any of its twelve positions the switch enables the LANE COUNT Counter (9) and the PERCENT OF LANE Meter (13) to display the phase difference between the channels selected by the switch. Example: in switch position 4-1, the meter and counter will display the phase difference, as percent of lane and lane number, between channels 4 and 1.

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
READOUT 1 Selector Switch	7	S7	Performs the same function as described for READOUT 2 Selector Switch except that it is used with LANE COUNT Counter (10) and PERCENT OF LANE METER (12).
PRESET Selector Switch	8	S4	Enables the operator to set the LANE COUNT Counter (9) to any desired Lane count between 000 and 999. In the DEC position a 10 PPS signal from the timing network is subtracted from the lane count. In the INC position the 10 PPS signal is added to the lane count.
LANE COUNT 2 Counter	9	MP2	Provides an integrated count of the number of times that phase difference of 2 radians between two channels (360°) occurs. The phase difference can be either positive or negative, thus the counter can count up or down. This counter is used in conjunction with READOUT 2 Selector Switch (6), PRESET Selector Switch (8), and PERCENT OF LANE Meter (13).
LANE COUNT 1 Counter	10	MP1	Provides the same function as LANE COUNT 2 Counter and is used in conjunction with READOUT 1 Selector Switch (7), PRESET Selector Switch (11), and PERCENT OF LANE Meter (12).
PRESET Selector Switch	11	S3	Provides the same function as PRESET Selector Switch (8) for LANE COUNT 1 Counter (10).
PERCENT OF LANE Meter	12	M1	Displays the phase difference between two channels as a percentage of the lane. Example: a change of 100% is equal to 2π radians or 360°. See description of READOUT 1 Selector Switch (7) and LANE COUNT 1 Counter (10).

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
PERCENT OF LANE Meter	13	M2	Provides the same function as described for PERCENT OF LANE Meter (12) except that this meter operates in conjunction with READ - OUT 2 Selector Switch (6) and LANE COUNT 2 Counter (9).
LAMP TEST Pushbutton	14	S2	Provides a means of checking the PHASE LOCK Indicator (16), (18), (19), and (21) bulbs. All four lamps should light when the pushbutton is depressed.
STATION SELECT CH4 Selector Switch	15	S1	Provides the means of selecting which transmitting station tracking channel 4 will be set to.
PHASE LOCK CH4 Indicator	16	DS1	When on, indicates that tracking channel 4 is phase locked to its selected transmitting station. When off, indicates that channel 4 is not phase locked with its station. Also, when off, causes TRACK/POWER LOSS Indicator (23) to light.
STATION SELECT CH3 Selector Switch	17	S5	Provides the same function for tracking loop filter 3 as described for STATION SELECT CH4 Selector Switch (15).
PHASE LOCK CH3 Indicator	18	DS2	Provides the same function for tracking channel 3 as described for PHASE LOCK CH4 Indicator (16).
PHASE LOCK CH2 Indicator	19	DS3	Provides the same function for tracking channel 2 as described for PHASE LOCK CH4 Indicator (16).
STATION SELECT CH2 Selector Switch	20	S6	Provides the same function for tracking channel 2 as described for STATION SELECT CH4 Selector Switch (15).
PHASE LOCK CH1 Indicator	21	DS4	Provides the same function for tracking channel 1 as described for PHASE LOCK CH4 Indicator (16).

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
STATION SELECT CH1 Selector Switch	22	S9	Provides the same function for tracking channel 1 as described for STATION SELECT CH4 Selector Switch (15).
TRACK/ POWER LOSS Indicator	23	DS5	When on, indicates that one of the four channels is not phase locked with its station or that the internal battery has discharged to less than 24 VDC at the battery. When off, indicates that all channels are phase locked to their stations and that there is sufficient power available to maintain system operation. NOTE: This lamp requires a push to reset.
POWER ON Indicator	24	DS6	When on, indicates that power is being supplied to all sections of the receiver. When off, indicates that power is not being supplied to all sections of the receiver.
TIMER RESET Pushbutton	25	S14	Provides a means of coarse time synchronization between the internal timing network pattern and the station pattern.
POWER STBY Indicator	26	DS7	When on, indicates that power is being supplied to the timing and oscillator units and to the internal battery charger.
POWER-OFF-STBY-ON Selector Switch	27	S15	In the OFF position no power is supplied to the receiver. In the STBY position power is supplied to the timing and oscillator units and to the internal battery charger (as indicated by POWER STBY Indicator (26)). In the ON position power is supplied to all sections of the receiver (as indicated by the POWER ON Indicator (24)).
REF PULSE Phone Jack	28	J1	Enables the operator to monitor the output of the timing network by earphones.

TABLE 3-1. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-1 Index Number	Reference Designation	FUNCTION
SYNC IND. SELECT Toggle Switch	29		Used in conjunction with the SYNC Meter (1) to provide two indications of whether or not the internal timing network is in synchronization with the station pattern. In the LOCK position the meter will indicate a maximum positive reading when the timing systems are in synchronization. In the ERROR position the meter will indicate a zero reading when the timing systems are in synchronization. NOTE: The zero reading obtained in the ERROR position may be ambiguous unless coincident with a maximum SYNC meter reading with the SYNC IND SELECT Switch in the LOCK position.

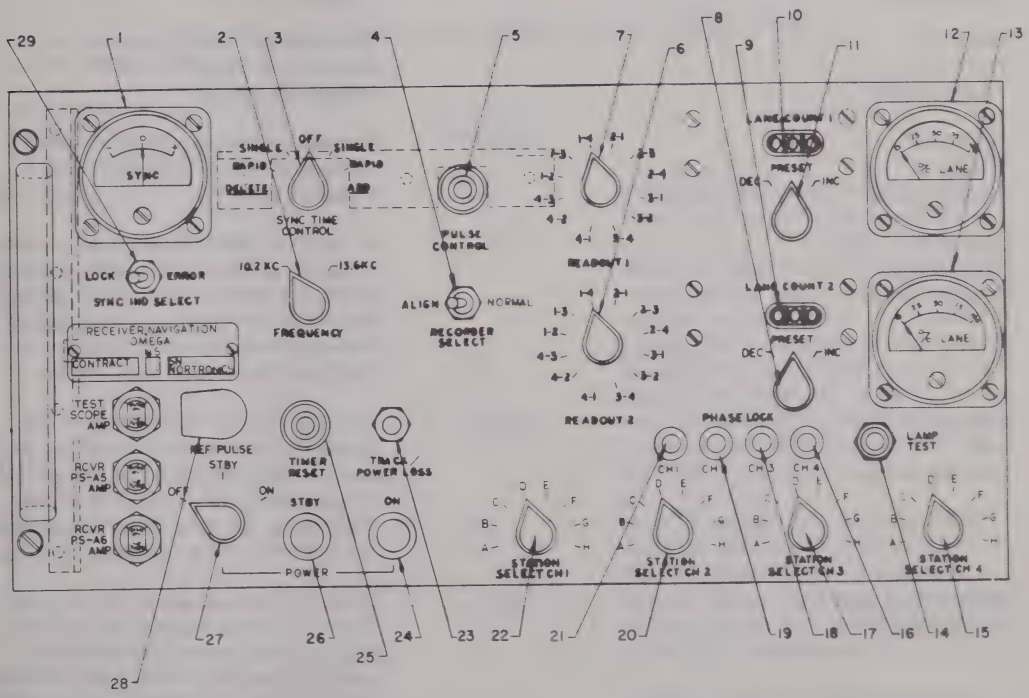


Figure 3-1. Receiver Front Panel Controls and Indicators

TABLE 3-2. RECEIVER AUXILIARY PANEL CONTROLS AND INDICATORS

Control or Indicator	Figure Number 3-2 Index Number	Reference Designation	FUNCTION
STATION TEST CH 1 Toggle Switch	1	S21	In the STATION position the receiver strip operates on the signal from the transmitter selected for the channel. In the TEST position the receiver strip operates on an internally generated test signal at the time the receiver would normally receive the transmitter signal.
STATION TEST CH 2 Toggle Switch	2	S20	Provides the same function described for STATION TEST CH 1 Toggle Switch (1).
STATION TEST CH 3 Toggle Switch	3	S19	Provides the same function described for STATION TEST CH 1 Toggle Switch (1).
STATION TEST CH 4 Toggle Switch	4	S18	Provides the same function described for STATION TEST CH 1 Toggle Switch (1).
COH ENV - NON COH ENV Toggle Switch	5	S17	In the COH ENV Position supplies the coherent detected envelope as the input to the test oscilloscope. In the NON COH ENV position supplies the non-coherent detected envelope as the input to the test oscilloscope.
GAIN NON COH ENV Potentiometer	6	1A1R1	Used to vary the amplitude of the detected non-coherent envelope as the input to the test oscilloscope so that a reasonable deflection can be observed for the weakest input signal to the receiver strip.
HIGH VOLTAGE ON Indicator	7	DS	When ON indicates that 115V Line Power is being supplied to the test oscilloscope power transformer primary and that the SCOPE POWER ON/OFF Toggle Switch is in the ON position. The oscilloscope internal power supply develops -1035 Vac. When OFF indicates that line power is not available to the oscilloscope or that the toggle switch is in the OFF position.

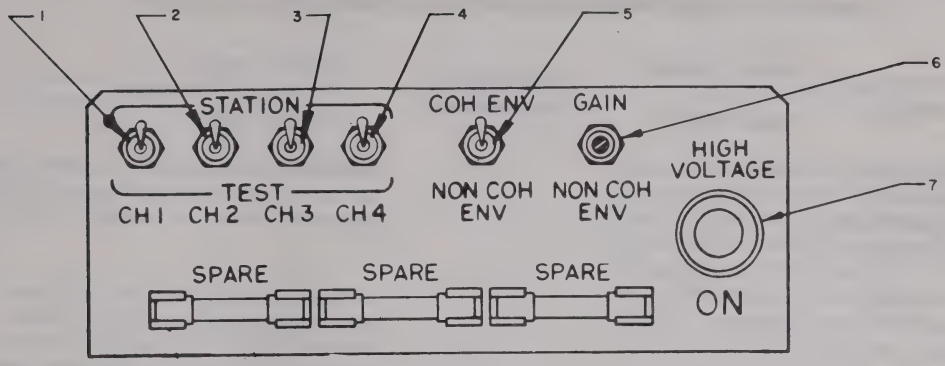


Figure 3-2. Receiver Auxiliary Panel Controls and Indicators

TABLE 3-3. TEST PANEL CONTROLS AND INDICATORS

Control or Indicator	Figure Number 3-3 Index Number	Reference Designation	FUNCTION
METER	1	M	Provides indication of the results of tests performed on the receiver.
SENSITIVITY CONTROL Pushbutton	2	S	While the pushbutton is depressed the sensitivity of the METER (1) is increased by a factor of 10. Used when testing the oscillators to enable small variations in oscillator control voltages to be observed. CAUTION: The SENSITIVITY CONTROL pushbutton should only be used when the METER (1) is close to or at null.
OSC MON Selector Switch	3	S	Used in conjunction with the TEST METER Selector Switch (9) in the OSC MON position to select the channel being monitored. Also used in conjunction with the SENSITIVITY CONTROL pushbutton (2).
EXT SYNC MEMORY Toggle Switch	4	S	Used in conjunction with the REC TEST SELECT Selector Switch (8) in the EXT SYNC position in which the channel under test is locked to a station or a test signal from the Test Signal Generator unit; or in the

TABLE 3-3. TEST PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-3 Index Number	Reference Designation	FUNCTION
EXT SYNC MEMORY Toggle Switch (continued)			MEMORY position in which oscillator under test input-control input from the phase detectors is opened.
VCO LOCK SEARCH Toggle Switch	5	S	In the LOCK position the VCO under test, as selected by the OSC MON Selector Switch (3), operates in the normal mode; either locked to the input signal from the phase detectors or a test signal from the Test Signal Generator Unit (the EXT SYNC position of the EXT SYNC - MEMORY Toggle Switch (4)) or at its last set position (the MEMORY position of the EXT SYNC - MEMORY Toggle Switch (4)). In the HIGH position slews the oscillator through its control range above the normal operating frequency. In the LOW position slews the oscillator through its control range below the normal operating frequency.
TIMER TEST	6	S	In the NORMAL position enables the detected envelope to be transmitted to the graphic recorder, as well as the reference pulse from the timing network, when the RECORDER SELECT Switch (Table 3-1, index no. 4) is in the ALIGN position. In any other position one of the station or sync gates and the reference plus will be transmitted to the graphic recorder.
ENV/TIMER TEST Test Jack	7	J	Enables the detected envelope or the station or sync gates (depending on the position of the TIMER TEST Selector Switch (6)) to be displayed on the test oscilloscope. Note: When the TIMER TEST Selector Switch is in the NORMAL position the detected envelope is available at the jack.

TABLE 3-3. TEST PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-3 Index Number	Reference Designation	FUNCTION
REC TEST SELECT Selector Switch	8	S	Enables the selection of the VCO from which the Test Signal Generator Unit will derive the test signal. In the OFF position no test signal will be derived nor will the EXT SYNC-MEMORY Toggle Switch (4) have any effect on system operation.
TEST METER Selector Switch	9	S	In the OFF position no tests can be performed since the METER (1) is grounded on both sides. Clockwise from OFF, the first eight positions enable the voltages of the power supplies to be checked. The four positions associated with TRACKER enables the testing of the tracking loop oscillators. The TEST GEN position enables the testing of the Test Signal Generator Unit to verify the existence of a test signal. The OSC MON position enables the METER (1) to display the dc control voltage to the VCO selected by the OSC MON Selector Switch (3).

TABLE 3-4. TEST OSCILLOSCOPE FRONT PANEL CONTROLS AND INDICATORS

Control or Indicator	Figure Number 3-4 Index Number	Reference Designation	FUNCTION
VERTICAL POSITION Potentiometer	1	1A1A7R2	Used to center the trace vertically.
HORIZONTAL GAIN Potentiometer	2	1A1A7R4	Used to set the width of the trace.
HORIZONTAL POSITION Potentiometer	3	1A1A7R5	Used to center the trace horizontally.

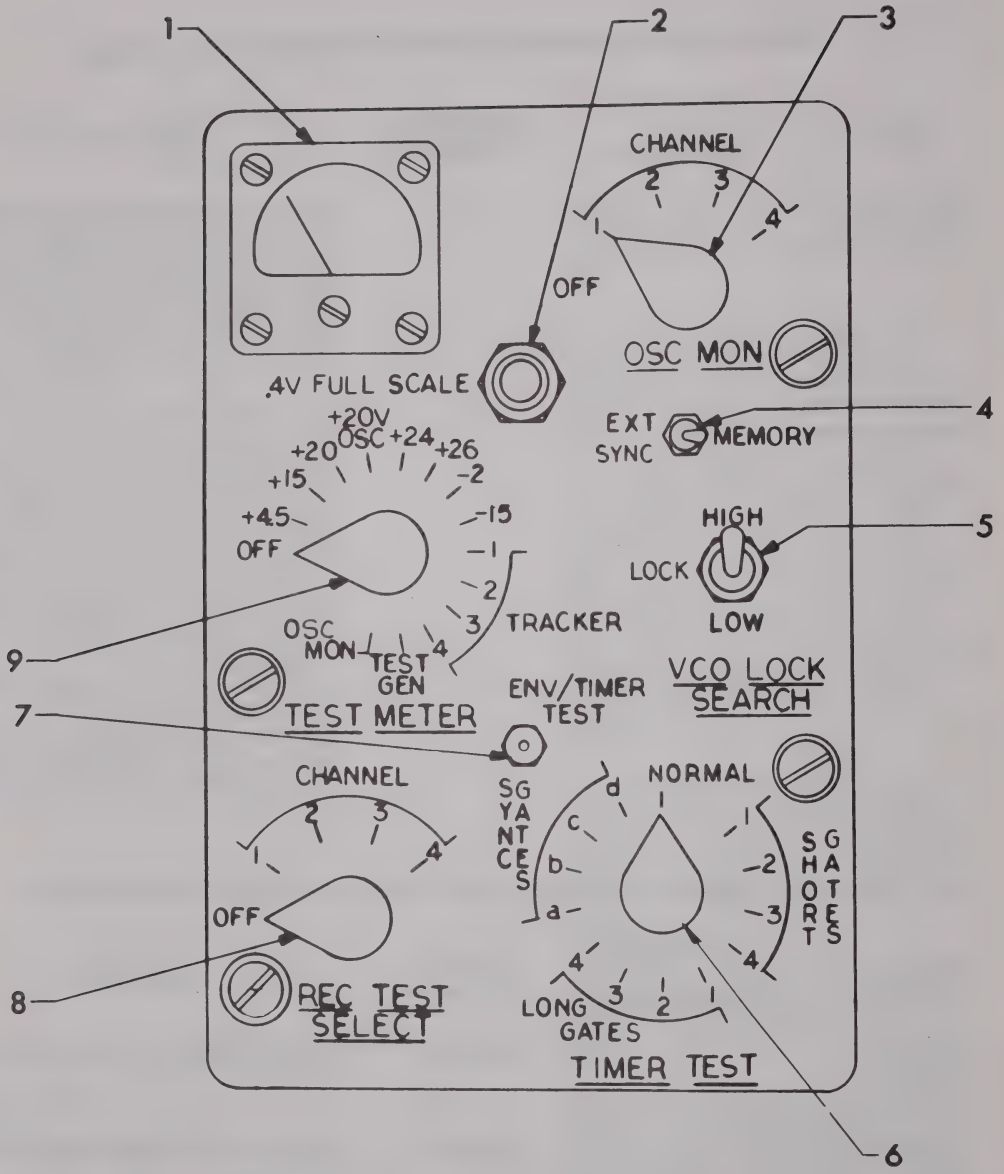


Figure 3-3. Test Panel Controls and Indicators

TABLE 3-4. TEST OSCILLOSCOPE FRONT PANEL CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-4 Index Number	Reference Designation	FUNCTION
CATHODE RAY TUBE Indicator	4	V1	Provides display of traces for observation.
BRIGHTNESS Potentiometer	5	1A1A7R4	Used to set the brightness of the trace.
FOCUS Potentiometer	6	1A1A7R9	Used to set the focus of the trace.
FUNCTION Selector Switch	7	S2	In position 1 the detected envelope is displayed along with the gating pattern for comparison. In position 2 the envelope from the receiver front end is displayed. In position 3 signals at various test points on receiver are displayed by use of probes.
TRACE STEP Potentiometer	8	1A1A7R15	Used to vary the separation between two simultaneous traces.
POWER ON/OFF Toggle Switch	9	S6	Provides input power control.

TABLE 3-5. TEST OSCILLOSCOPE SHELF CONTROLS AND INDICATORS

Control or Indicator	Figure Number 3-5 Index Number	Reference Designation	FUNCTION
ASTIGMATISM Adjustment Control	1	1A1A7R1	Adjustment for fine focus of the scope trace. Interacts with the front panel focus control.
EXT SIG	2	J2	Provides input connection for the External Signal Test Probe.
EXT TRIG Jack	3	J3	Provides input connection for External Trigger to synchronize External Test Probe Signals.
TRIG LEVEL Potentiometer	4	1A1A7R3	Provides adjustment so that trigger sweep appears on the scope and will be stable.

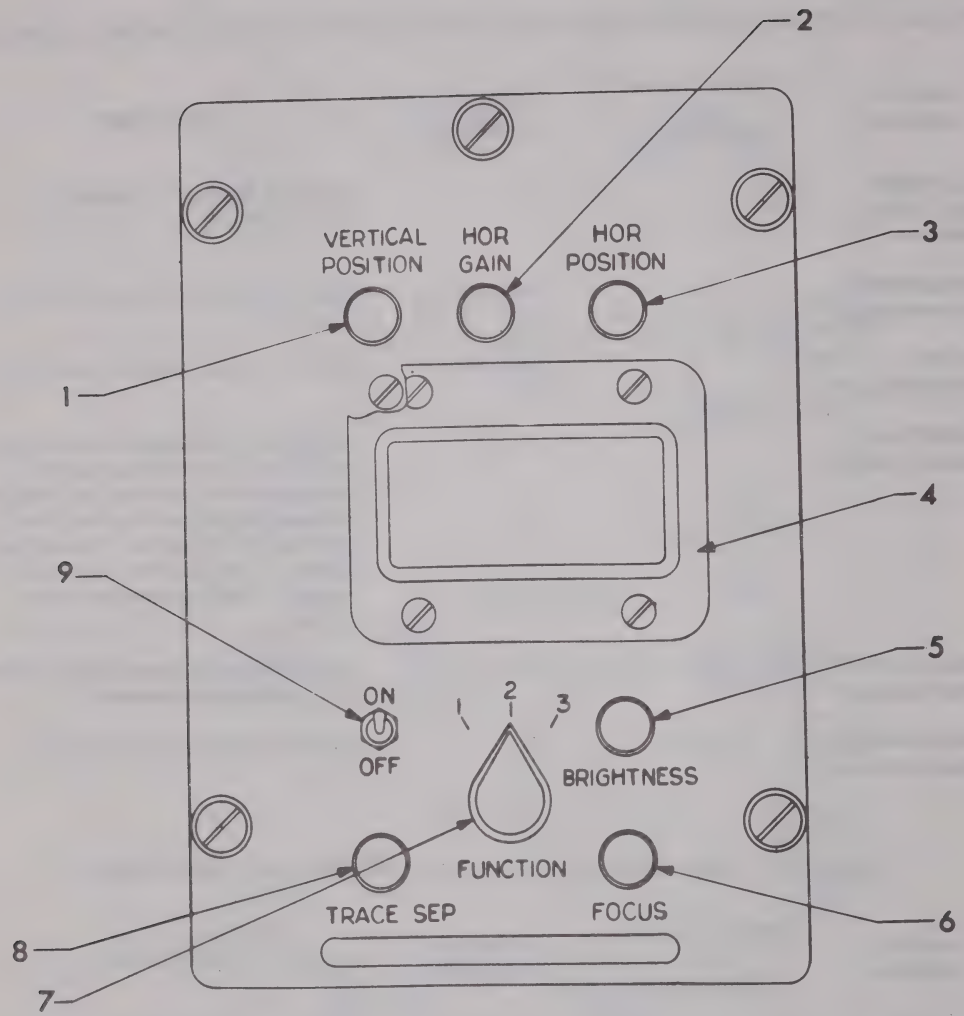


Figure 3-4. Test Oscilloscope Front Panel Controls and Indicators

TABLE 3-5. TEST OSCILLOSCOPE SHELF CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-5 Index Number	Reference Designation	FUNCTION
TRIG PO Toggle Switch	5	S3	Set at either the + or - position. Normal position is +. Set - when it is desired to invert the trigger signal on the scope.
HF COMP Potentiometer	6	R	Provides adjustment for obtaining a flat topped square wave.
VERT GAIN Selector Switch	7	S101	Provides vertical gain adjustment of observed input signals from the Test Probe. In the OPR position the vertical deflection circuit input is connected to the envelope or limiter input signals from the receiver. In the 10, 2, or 1 position the vertical deflection input is connected to the External Signal jack via either the divided by 10 or by 2 attenuator networks, or is connected straight through with no attenuation via the 1:1 network. The 10, 2, or 1 positions disconnect the input from the FUNCTION switch which had been made in the OPR position.
TRIG SOURCE Selector Switch	8	S202	Allows selection of the particular source of signal required to trigger and synchronize the oscilloscope horizontal sweep circuits. In the OPR position, the normal position of the switch, the source of signal depends upon the position of the front panel FUNCTION switch. With the switch in position 1 or 2, the source of signal is either from the REF INPUT SOURCE or from the output of the vertical amplifier waveform under observation, respectively. In the REF position the horizontal trigger sweep comes directly from the REF INPUT, bypassing the FUNCTION switch. In the EXT position the horizontal sweep circuits are driven by the trigger shaper and amplifier whose input is switched directly to the EXT TRIG input jack.

TABLE 3-5. TEST OSCILLOSCOPE SHELF CONTROLS AND INDICATORS (continued)

Control or Indicator	Figure Number 3-5 Index Number	Reference Designation	FUNCTION
TRIG SOURCE Selector Switch (continued)			In the INT position the horizontal sweep circuits are driven by the trigger shaper and amplifier whose input comes from the TRIG Polarity switch. The sweep is thus synchronized to the observed vertical waveform.

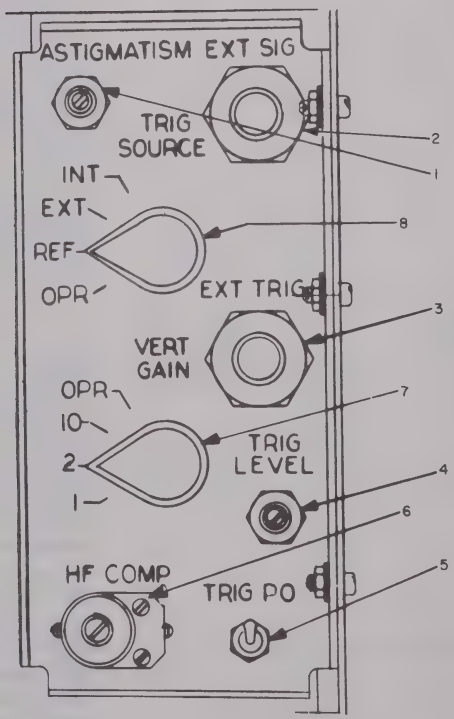


Figure 3-5. Test Oscilloscope Shelf Controls and Indicators

3-2-2. OPERATING INSTRUCTIONS

The following paragraphs contain step-by-step instructions for the complete sequence of operation of the Omega Navigation Receiving Set.

3-2-2-1. Before Use. These steps should be followed when the receiving set is turned off and it is desired to achieve the standby mode of operation.

STEP 1: Loosen the four captive screws, one at each corner, on the front of the receiver chassis.

STEP 2: Using the handles on both sides of the front of the receiver chassis, pull the chassis out of the receiver cabinet until the chassis slides lock into position.

STEP 3: Normal mode is the ten second timing sequence designed for eight stations. On cards 1A1A3A6 and 1A1A3A7, wiring jumpers may be connected to allow operation in a five-second pattern if this mode of operation is to be used.

NOTE: It is necessary to remove the above cards from the rack to set the wire jumpers in the desired position. Full instructions for complete conversion to the five-second pattern are given in STEP 3A.

STEP 3A: (a) On card 1A1A3A7 jumper the small printed circuit lands located between TP4 and TP5 as follows: connect C to D for ten-second pattern; connect A to B for the five-second pattern. On A36 leave pin 8 floating for ten-second pattern; connect pin 8 to terminal 41 for five-second pattern. (b) For card 1A1A3A6, on lower left part of card, connect jumper from terminal lug to A12, pin 8, for ten-second pattern; connect jumper to A12, pin 4, for five-second pattern. Record jumper position in each case as changed.

STEP 4: Turn the POWER OFF STBY ON Selector Switch from the OFF to the STBY position.

STEP 5: Observe that the POWER STBY Indicator Lamp turns on.

STEP 6: From 15 minutes to one-half hour (maximum) should elapse before turning the POWER STBY ON Selector Switch from the STBY position to the ON position. This warmup time depends on the outside temperature.

3-2-2-2. During Standby. These steps should be followed when the receiver is in the standby mode of operation and it is desired to achieve the normal mode of operation. It is not necessary to take these steps during the standby mode time interval, but is more convenient to do so.

STEP 1: Set the COH ENV - NON-COH ENV Toggle Switch to the NON-COH ENV position. This switch is located on the Receiver Auxiliary Panel (see figure 3-2, table 3-2).

STEP 2: Set the STATION TEST CH1 Toggle Switch to the STATION position. This and switches CH2 through CH4 are located on the Receiver Auxiliary Panel and are not to be confused with the front panel STATION SELECT rotary switches.

STEP 3: Set the STATION TEST CH2 Toggle Switch to the STATION position.

STEP 4: Set the STATION TEST CH3 Toggle Switch to the STATION position.

STEP 5: Set the STATION TEST CH4 Toggle Switch to the STATION position.

STEP 6: Set the OSC MON Selector Switch to the OFF position.

STEP 7: Set the EXT SYNC - MEMORY Toggle Switch to the EXT SYNC position.

STEP 8: Set the VCO LOCK SEARCH Toggle Switch to the LOCK position.

STEP 9: Set the TIMER TEST Selector Switch to the NORMAL position.

STEP 10: Set the REC TEST SELECT Selector Switch to the OFF position.

STEP 11: Set the TEST METER Selector Switch to the OFF position.

STEP 12: Set the FREQUENCY Selector Switch to the desired operating frequency; either 10.2 kc or 13.6 kc.

STEP 13: Set the SYNC TIME CONTROL Selector Switch to the OFF position.

STEP 14: Set the RECORDER SELECT Toggle Switch to the ALIGN position.

STEP 15: Set the SYNC IND SELECT Toggle Switch to the LOCK position.

STEP 16: Set the FUNCTION Selector Switch (Scope) to the 1 position.

STEP 17: Set the VERT GAIN Selector Switch (Scope) to the OPR position.

STEP 18: Set the TRIG SOURCE Selector Switch (Scope) to the OPR position.

NOTE: In some cases when the power is turned off or when switching from FUNCTION 2 to FUNCTION 1, the trace will be blanked and requires a set procedure for unblanking. The procedure is as follows:

1. With FUNCTION Switch at position 2, and the gain switch at OPR, and the TRIG SOURCE switch at INT, the 17 kc output from the final limiter will be presented on the tube.

2. Throw the FUNCTION switch from position 2 to position 1 and a five-second sweep pattern should appear; if it does not, throw the FUNCTION switch back to position 2 and repeat.

3. Once on the five-second pattern, throw the TRIG SOURCE switch to OPR and set up for normal operation.

3-2-2-3. Turn On. The following steps should be completed to apply full power to the receiver.

STEP 1: Check the time noted in 3-2-2-1, STEP 6, to ensure that warmup instructions have been followed before proceeding with the following steps.

STEP 2: Turn the POWER OFF-STBY-ON Selector Switch from the STBY to the ON position.

STEP 3: Observe that the POWER STBY Indicator Lamp turns off.

STEP 4: Observe that the POWER ON Indicator Lamp turns on.

STEP 5: Observe that the HIGH VOLTAGE ON Indicator Lamp turns on.

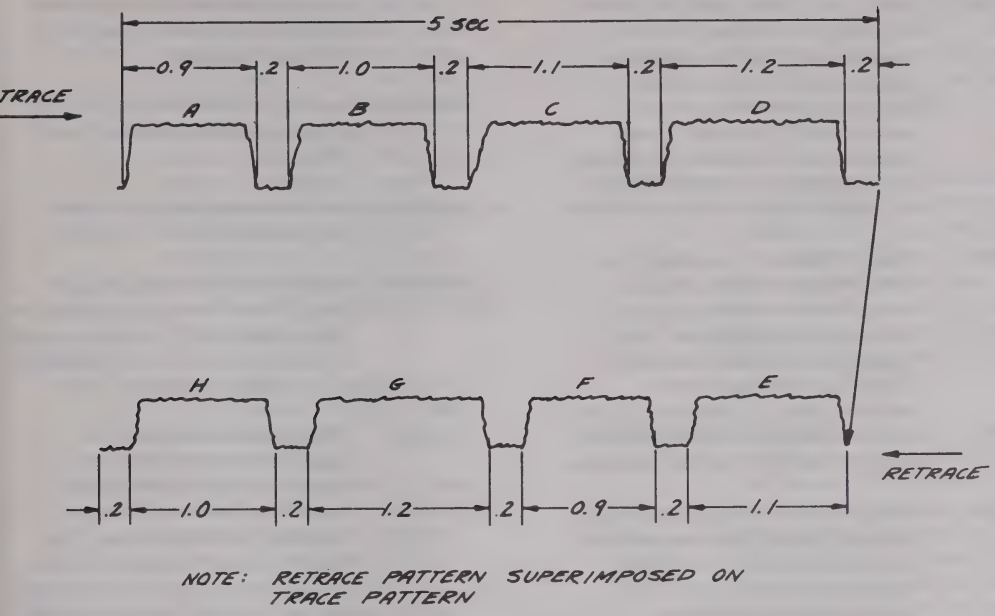


Figure 3-6. Eight Transmission Oscilloscope Pattern

WARNING: When the HIGH VOLTAGE ON Indicator Lamp is on, high voltages dangerous to life are present in the receiver. Personnel must observe all safety precautions at all times when the Indicator Lamp is on.

3-2-2-4. Tuning or Alignment. The tuning sequence consists of identifying the transmitting stations, coarse and fine synchronization of the internally generated (synthetic) station pattern with transmitter station pattern, and receiver phase lock.

3-2-2-4-1. Transmitter Station Identification. Basically, the various transmitting stations are identified by the relative time and position each station pulse occupies on the Test Oscilloscope sweep. Also, the operator knows (in most cases) which stations will be received in his particular area of operation and their probable order of signal strengths. For station identification the following steps should be followed:

STEP 1: Adjust the focus and brightness of the Test Oscilloscope as necessary.

STEP 2: If the transmitter station pulses do not appear, or if they are jittery, compensate by adjusting the GAIN-NON COH ENV potentiometer.

STEP 3: Position the traces on the Test Oscilloscope using the VERT POSITION and HOR POSITION potentiometers, so that the traces appear in the same relative positions as in figure 3-6.

STEP 4: Separate the traces on the TEST OSCILLOSCOPE as desired, using the TRACE STEP potentiometer.

STEP 5: Adjust VERT GAIN potentiometer for proper overall signal strengths.

STEP 6: To aid in identification of the various transmitting stations, compare the Test Oscilloscope presentation to figure 3-6. Station identification may be simplified by operator knowledge of which station or stations are strongest or expected to be strongest in the area of operation.

NOTE: Which stations are actually received depends upon receiver location and somewhat upon atmospheric conditions. Although eight stations normally transmit it will be found generally that a maximum of four or five stations will be received operationally at any one location.

STEP 7: Identify the various transmitting stations by the relative position and duration of the received pulses displayed on the Test Oscilloscope as shown in figure 3-6.

3-2-2-4-2. Coarse and Fine Synchronization. To accomplish synchronization the following steps should be completed. Several alternative procedures are given, the first using an internal test signal and being the most accurate and preferable; the second method is recommended when Station A is being received strongly or as an alternative procedure to the first. Also the use of the Recorder for synchronization is explained and may be used if necessary.

First method, STEP 1: Select two received signals of good strength which have been identified. These should preferably be separated by one transmitted interval, such as Stations B and D. Station C (internally generated) will be inserted between the received signals in the following steps and synchronization will thereby be accomplished.

STEP 2: Set front panel rotary switch STATION SELECT CH1 to Station C (in this case) or to another station which has been selected by the operator to fit his requirements.

STEP 3: Set REC TEST SELECT switch on test panel to channel 1 (not OFF).

STEP 4: Set Receiver Auxiliary Panel Toggle Switch CH1 to TEST.

STEP 5: Observe on the Test Oscilloscope that a test signal appears. This signal will probably be out of position but will be positioned in the following steps.

NOTE: The generation of the test signal may be checked by placing the TEST METER switch on the Test Panel at the TEST GEN position. The meter indicator should deflect to the green area of the positive scale. On the Oscilloscope the test signal will be steadier and less noisy than the received signals.

STEP 6: To position the test signal between the two received signals (in this case), place the front panel control SYNC TIME CONTROL on either ADD RAPID (if test signal is to left of its slot) or DELETE RAPID (if signal is to right of its slot) and depress the PULSE CONTROL pushbutton. If the test signal is very close to its slot or position, move it more slowly, using the ADD SINGLE or DELETE SINGLE positions of the control.

STEP 7: Using careful adjustments, in the above step, adjust the test signal so that it falls squarely between the two received signals. Place SYNC TIME CONTROL to OFF. Synchronization is now accomplished.

NOTE: The above process can be carried out using other combinations of received and/or test signals. For example, the test signal can be moved ajacent to a single received signal. Also, two test signals can be bracketed around a single received signal by setting rotary switches STATION SELECT CH1 and CH2 to two desired test signals and toggle switches CH1 and CH2 to TEST. Proceed as above.

STEP 8: After use of test signal, set Toggle Switches CH1 through CH4 to STATION.

STEP 9: Adjust the Sync Meter (front panel) reading for a maximum by setting the SYNC TIME CONTROL to either SINGLE (close to maximum) or RAPID (if further from maximum) DELETE or ADD depending upon whether the SYNC meter indicator moves toward a maximum when the PULSE CONTROL pushbutton is depressed.

STEP 10: After a maximum is reached, release the PULSE CONTROL pushbutton.

STEP 11: Set the SYNC IND SELECT Toggle Switch to the ERROR position and observe that the SYNC meter reads a minimum (near zero). If the meter does not indicate approximately zero, add or delete pulses as necessary to bring the meter to a minimum. Some deviation from zero may be caused by noise or strong signal strengths.

STEP 12: On the Test Oscilloscope observe that the internally generated (synthetic)synchronization gate pulses occur nearly coincident in time with the transmitting station's pulses.

Second Method (best for a strong Station A or as an alternative to the first method. Omit second method if synchronization has been accomplished using the first method).

STEP 1: If Station A is present and sufficiently strong, depress the TIMER RESET pushbutton at the instant Station A appears on the oscilloscope screen. This accomplishes coarse synchronization in one step. If Station A is not present, skip STEP 1 and proceed with STEP 1A.

STEP 1A: If Station A does not appear, identify the strongest station visible and calculate the number of seconds its leading edge occurs after the leading edge of the missing Station A (use figures 1-4 and/or 3-6 for this calculation.) Subtract this number from 10. The remainder will be the number of seconds after the received strong station that the leading edge of Station A should occur. At the instant Station A should occur depress the TIMER RESET pushbutton. This accomplishes coarse synchronization.

EXAMPLE: If the Station C transmitted pulse is the strongest received and Station A is not seen, one can determine that the leading edge of Station C pulse occurs 2. 3 seconds after the leading edge of Station A using figure 1-4. By subtracting 2. 3 from 10, determine that the leading edge of Station A should occur 7. 7 seconds after the leading edge of the Station C pulse. Measure accurately a period of 7. 7 seconds after Station C starts and instantly depress the TIMER RESET pushbutton; the required interval may be measured by a stopwatch or other accurate method.

STEP 2: Adjust the SYNC METER (front panel) reading for a maximum by setting the SYNC TIME CONTROL to either SINGLE (close to maximum) or RAPID (further from maximum) DELETE or ADD depending upon whether the meter indicator moves toward a maximum when the PULSE CONTROL pushbutton is depressed.

STEP 3: After a maximum is attained, release the PULSE CONTROL pushbutton.

STEP 4: Set the SYNC IND SELECT Toggle Switch to the ERROR position and observe that the SYNC meter reads a minimum (near zero). If the meter does not indicate approximately zero, add or delete pulses as necessary to bring the meter to a minimum. Some deviation from zero may be caused by noise or strong signal strengths.

STEP 5: On the Test Oscilloscope observe that the internally generated (synthetic) synchronization gate pulses occur nearly coincident in time with the transmitting station's pulses.

Synchronization Using Recorder: If the Test Oscilloscope is not operating it is possible to perform coarse synchronization using the Recorder. This will be easily understood after experience with the Oscilloscope since the method is similar and only the means of observing the recorded signals is different. To use the Recorder, perform the following preparatory steps in addition to the normal procedure of Station Identification. The necessary traces will then be seen on the Recorder Chart.

STEP 1: Set Recorder chart drive to 12 inches per minute. This gives a value of 1.25 seconds per division.

STEP 2: Set COH ENV - NON COH ENV Toggle Switch (Auxiliary Panel) to the NON COH ENV position.

STEP 3: Set RECORDER SELECT switch to the ALIGN position.

STEP 4: Observe station pulses on one channel and the reference pulse on the other.

STEP 5: If the station pulses are not visible or too high, adjust the GAIN NON COH ENV potentiometer.

STEP 6: Synchronize the Reference Pulse and Station A (if present) by depressing TIMER RESET pushbutton when Station A occurs. This operation is similar to STEP 1, Second Method.

STEP 6A: Synchronize (if Station A is missing) similarly to STEP 1A and EXAMPLE, Second Method.

NOTE: Test signals (as in First Method) may be used if desired. Use of test signals is always a very satisfactory method for synchronization. Figure 3-6 shows the proper signal intervals and durations.

STEP 7: Observe that either the Reference Pulse coincides with the leading edge of Station A; or that the test signal(s) (if used) fall into their proper places. The Reference Pulse then coincides with the Station A position if Station A is absent.

STEP 8: Perform STEPS 8 through 11 of the First Method for finer synchronization.

STEP 9: Turn the Recorder to the OFF position and proceed with Phase Locking.

STEP 10: Return RECORDER SELECT switch to NORMAL.

3-2-2-4-3. Phase Lock. The following procedure consists of achieving phase lock with the transmitter station pulses. To accomplish phase lock the following steps should be completed.

STEP 1: Set STATION SELECT CH1 (front panel rotary switch) to the station producing the strongest signal at the receiver.

STEP 2: Set STATION SELECT CH2, CH3, and CH4 to other stations.

STEP 3: Set the TEST METER Selector Switch to the OSC MON position.

STEP 4: Set the OSC MON Selector Switch to the Channel 1 position.

STEP 5: TEST METER (figure 3-3) should read 0±. 1 volt for phase lock. If meter indicator reads high (positive) set VCO LOCK SEARCH control to LOW; if low, set VCO LOCK SEARCH control to HIGH. Ignore all "kicks" while needle moves toward zero.

STEP 6: When meter indicator reaches a point between ± . 4 volts, depress the . 4 VOLT FULL SCALE pushbutton. Continue toward objective of 0 ± . 1 volt for full phase lock.

STEP 7: When meter indicator just crosses zero and gives a slight "kick" in the same direction, set VCO LOCK SEARCH control to LOCK.

STEP 8: Set the OSC MON Selector Switch to Channel 2 position and follow the procedure in STEPS 7 through 9.

STEP 9: Set the OSC MON Selector Switch to Channel 3 position and follow the procedure in STEPS 7 through 9.

STEP 10: Set the OSC MON Selector Switch to Channel 4 position and follow the procedure in STEPS 7 through 9.

STEP 11: Observe that the CH1 through CH4 PHASE LOCK Indicator Lamps remain ON. TRACK/ POWER LOSS Indicator Lamp should be OFF.

STEP 12: Return the OSC MON Selector Switch to the Channel 1 position and recheck meter reading using the ± . 4 volt scale. It should have remained at 0 ± . 1 volt after several minutes of operation.

STEP 13: If the meter reading is incorrect, repeat STEPS 5 through 13. Do not attempt to readjust CH2 through CH4 without first readjusting CH1.

NOTE: Oscillator drift may in time cause a movement of the phase lock point reached in STEP 7. If oscillators require realignment, follow method given in Sections 3-2-2-4-4.

3-2-2-4-4. Oscillator Alignment. Every two to three months, or whenever necessary, the four oscillators should be checked and adjusted. This is done using a digital frequency meter, preferably while the ship is in port. Oscillators should be adjusted if the phase lock points reached for all oscillators in STEP 9 above drift away from zero with the passage of time. Generally, the oscillators should be maintained at a frequency of 816000. 0 ± . 2 cycles.

Oscillator Alignment Procedure:

STEP 1: Looking at the under side of the receiver, short pin 5 on each VCO Module (figure 1-1) to ground.

STEP 2: With receiver controls set as in the previous paragraph, monitor pin no. 7 on VCO

Module 1A1Y1 with a digital frequency meter having an accuracy of ±. 2 cycle. Frequency should read 816000. 0 ±. 2 cycles.

STEP 3: If monitored frequency is outside the prescribed range, remove the weathertight screw on the top of the VCO shield can and, using tuning device, adjust inside screw until frequency is correct.

STEP 4: Repeat STEPS 2 and 3, monitoring pin 7 on each VCO, for all VCO's.

STEP 5: Unground pin 5 on each VCO base when adjustments are completed.

3-2-2-5. Normal Operation Mode. For normal operation of the receiver set after phase lock and time synchronization have been achieved, the following steps should be completed.

STEP 1: Set LANE COUNTER 1 and LANE COUNTER 2 to zero using appropriate PRESET Selector Switches when the system is at the beginning of a cruise.

STEP 1A: To decrease the lane count to zero, set the PRESET Selector Switch to the DEC position.

STEP 2: Set LANE COUNTER 1 and LANE COUNTER 2 to the appropriate number of lanes for the system's position if the system is being brought into operation at a specific location.

STEP 3: Set READOUT 1 Selector Switch to the position that will enable the LANE COUNT 1 Counter and PERCENT OF LANE Meter to display the desired phase difference between any two channels.

STEP 4: Set READOUT 2 Selector Switch to the position that will enable the LANE COUNT 2 Counter and PERCENT OF LANE Meter to display the desired phase difference between any two channels.

STEP 5: Set the RECORDER SELECT Selector Switch to the NORMAL position.

STEP 6: Set the POWER ON-OFF Toggle Switch to the OFF position.

STEP 7: Observe that the HIGH VOLTAGE ON Indicator Lamp turns off.

STEP 8: Return the receiver chassis to the receiver cabinet and tighten the four captive screws.

3-2-2-6. Turn Off. To place the receiver set in the standby mode of operation when it is in the normal operation mode, set the OFF-STBY-ON Selector Switch from the ON position to the STBY position. Observe that the POWER ON Indicator Lamp turns off and that the POWER STBY Indicator Lamp turns on.

3-2-2-7. Secure. To secure the receiver, set the OFF-STBY-ON Selector Switch to the OFF position. Observe that neither the POWER ON nor POWER STBY Indicator Lamps are turned on.

Ensure that the POWER ON-OFF Toggle Switch is in the OFF position.

3-3. SUMMARY OF OPERATING PROCEDURES

3-3-1. SCOPE

The following sections describe the procedural steps for operation of the Omega Navigation Receiving Set. Although this information enables the inexperienced operator to use the equipment without further study, it is recommended that those persons wishing fullest comprehension initially use Section 3-2-2. After familiarization, the following abbreviated section is best used as a checklist, especially for the tuning (synchronization) procedures.

3-3-2. SUMMARY

Table 3-6 is a summary of Operating Procedures.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES

SEQUENCE	PROCEDURES
FROM OFF TO STANDBY	1. Remove captive screws and pull chassis out of receiver.
	2. If necessary to change duration of pattern, follow instructions in Sec. 3-2-2-1, STEP 3A.
	3. Turn POWER OFF-STBY-ON Selector Switch to STBY position.
	4. POWER STBY Indicator Lamp will illuminate.
	5. Wait from 15 to 30 minutes before turning POWER OFF-STBY-ON Selector Switch to ON position (see: FROM STBY TO ON).
DURING STBY	1. Set COH ENV-NON COH ENV Toggle Switch to NON COH ENV position.
	2. Set STATION TEST CH1, CH2, CH3, and CH4 to the STATION position.
	3. Set OSC MON Selector Switch to OFF position.
	4. Set EXT SYNC-MEMORY Toggle Switch to EXT SYNC position.
	5. Set VCO LOCK SEARCH Toggle Switch to LOCK position.
	6. Set TIMER TEST Selector Switch to NORMAL position.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES (continued)

SEQUENCE	PROCEDURES
DURING STBY (continued)	7. Set REC TEST SELECT Selector Switch to OFF position.
	8. Set TEST METER Selector Switch to OFF position.
	9. Set FREQUENCY Selector Switch to desired frequency, either 10. 2 or 13. 6 kc.
	10. Set SYNC TIME CONTROL Selector Switch to OFF.
	11. Set RECORDER SELECT Toggle Switch to ALIGN position.
	12. Set SYNC IND SELECT Toggle Switch to LOCK position.
	13. Set FUNCTION Selector Switch to 1 position.
	14. Set VERT GAIN Selector Switch to OPR position.
	15. Set TRIG SOURCE Selector Switch to OPR position.
FROM STBY TO ON	1. From 1/4 to 1/2 hour (maximum) must elapse before proceeding from STBY to the ON position.
	2. Turn POWER OFF-STBY-ON Selector Switch to ON position.
	3. To eliminate possible oscilloscope blanking follow instructions in NOTE in paragraph 3-2-2-2.
TUNING OR ALIGNMENT	1. STATION IDENTIFICATION
	A. Adjust focus and brightness of Test Oscilloscope.
	B. Adjust GAIN-NON COH ENV potentiometer.
	C. Position traces on scope using VERT AND HOR POSITION potentiometers.
	D. Use TRACE STEP potentiometer for separation of traces.
	E. Identify transmitting stations by relative position and duration of received pulses displayed on Test Oscilloscope.
	2. COARSE AND FINE SYNCHRONIZATION (First Method)
	A. Select a single isolated signal or preferably two good signals separated by one absent station. Subsequent steps will accomplish synchronization by inserting a test signal in the correct place either (1) by placing it adjacent to the single received signal, or (2) by placing it exactly between two received signals.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES (continued)

SEQUENCE	PROCEDURES
TUNING OR ALIGNMENT (continued)	B. For an isolated signal, set Auxiliary Panel Switch CH1 to TEST.
	C. Set front panel STATION SELECT CH1 to the wanted test signal. (Example: If received signal is D, operator may select adjacent test signal C.)
	C.1 Set REC TEST SELECT switch on test panel to channel 1 (not OFF).
	D.1 Position signal C just to the left of and adjacent to received signal D by use of SYNC TIME CONTROL and PULSE CONTROL (ADD for movement to right; DELETE for left movement). This accomplishes synchronization.
	D.2 For inserting test signal between two signals, obtain test signal desired as in STEP C. Position signal exactly between received signals using SYNC TIME CONTROL and PULSE CONTROL as in STEP D.1.
	NOTE Two test signals for bracketing a single received signal may be obtained by setting controls CH1 and CH2 (Auxiliary Panel) to TEST and selecting two test signals on front panel switches CH1 and CH2. Proceed after obtaining signals as in STEP D except that test signals bracket a single received signal. This is an accurate method and should be used if feasible.
	E. Set Auxiliary Panel Toggle Switches CH1 through CH4 to STATION, disconnecting internal test signals.
	F. Adjust the SYNC METER (front panel) to maximum by setting SYNC TIME CONTROL to either SINGLE or RAPID, DELETE or ADD depending upon direction of meter movement when PULSE CONTROL pushbutton is depressed.
	G. On reaching maximum, release PULSE CONTROL pushbutton.
	H. Set SYNC IND SELECT Toggle Switch to ERROR position.
	I. If SYNC METER does not read minimum (approximately zero) add or delete pulses as necessary to bring the meter to a minimum.
	J. Set SYNC TIME CONTROL Selector Switch to OFF.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES (continued)

SEQUENCE	PROCEDURES
TUNING OR ALIGNMENT (continued)	2a. COARSE AND FINE SYNCHRONIZATION (Second Method) A. If STATION A is present, depress TIMER RESET pushbutton at the instant that STATION A appears on the Oscilloscope. This accomplishes coarse synchronization. B. When Station A is absent or weak, use the strongest identified station and, using figures 1-4 and/or 3-6, calculate the number of seconds it occurs after Station A. Subtract this value from 10, obtaining the time after the strongest station that Station A should occur (leading edges only). Depress the TIMER RESET pushbutton instantly at this time. This accomplishes synchronization similarly to STEP A. C. On Test Oscilloscope, observe that the internally generated (synthetic) sync gate pulses occur nearly coincident in time with the received pulses. D. Complete STEPS G through K of First Method, SUMMARY. 2b. SYNCHRONIZATION USING RECORDER. Use the following generally if the Test Oscilloscope is not available. A. Set Recorder to 12 inches per minute (1.25 seconds/division). B. Set COH ENV-NON COH ENV switch to NON COH ENV. C. Set RECORDER SELECT switch to ALIGN. D. Observe Station and Reference pulses. E. Adjust GAIN NON COH ENV potentiometer if necessary. F. Synchronize Reference Pulse with Station A (if present) by depressing TIMER RESET pushbutton when Station A occurs. (Procedure similar to STEP 2a, A, of Summary.) G. If Station A is missing, synchronize as STEP 2a, B, of Summary. NOTE Test signals may also be used for synchronization if desired as in procedure for synchronization using Test Oscilloscope.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES (continued)

SEQUENCE	PROCEDURES
TUNING OR ALIGNMENT (continued)	H. Observe that Reference Pulse coincides with leading edge of Station A or its position. Test signals should fall into their correct positions (figure 3-6) if they are used.
	I. Perform STEPS 2F through 2J of Summary.
	J. Proceed with Phase Locking.
	3. PHASE LOCK PROCEDURE
	A. Set front panel rotary switch STATION SELECT CH1 to strongest received signal.
	B. Set STATION SELECT CH2 to second strongest received signal.
	C. Set STATION SELECT CH3 to third strongest signal.
	D. Set STATION SELECT CH4 to fourth strongest signal.
	E. Set TEST METER Selector Switch to the OSC MON position.
	F. Set OSC MON Selector Switch to Channel 1 position.
	G. Adjust TEST METER (figure 3-3) to 0 ± .1 volt by setting VCO LOCK SEARCH to LOW if meter indicator reads high; if meter indicator reads low, set VCO LOCK SEARCH to HIGH.
	H. When meter indicator reaches a point between ± .4 volt, depress the .4 VOLT FULL SCALE pushbutton to increase accuracy.
	I. When meter indicator just crosses zero and kicks slightly in the same direction, set VCO LOCK SEARCH control to LOCK.
	J. Set the OSC MON Selector Switch to CHANNEL 2 position and follow procedure in STEPS G through I.
	K. Set the OSC MON Selector Switch to CHANNEL 3 position and follow procedure in STEPS G through I.
	L. Set the OSC MON Selector Switch to CHANNEL 4 position and follow procedure in STEPS G through I.
	M. The CH1 through CH4 PHASE LOCK Indicator Lamps should remain ON. TRACK/POWER LOSS Indicator Lamp should remain OFF.

TABLE 3-6. SUMMARY OF OPERATING PROCEDURES (continued)

SEQUENCE	PROCEDURES
TUNING OR ALIGNMENT (continued)	N. Reset OSC MON Selector Switch to CHANNEL 1 and recheck TEST METER reading. It should be at 0 ± .1 volt after several minutes. O. If the reading is incorrect now or later, repeat STEPS G through M. NOTE Oscillator drift may in time cause a movement of the phase lock point reached in STEP G. If this happens, realign oscillators (Paragraph 3-2-2-4-4) when in port and then repeat FINE TUNING.
FROM TUNING TO NORMAL OPERATION	1. Set LANE COUNTER 1 and LANE COUNTER 2 to zero using appropriate PRESET Selector Switches. 2. Set PRESET Selector Switch to DEC position to decrease lane count to zero. 3. Set LANE COUNTER 1 and LANE COUNTER 2 to appropriate number of lanes for systems position if system is being brought into operation at a specific location. 4. Set READOUT 1 Selector Switch to position that will enable LANE COUNT 1 Counter and PERCENT OF LANE Meter to display desired phase difference between any two channels. 5. Follow same procedure for READOUT 2. 6. Set RECORDER SELECT Selector Switch to NORMAL position. 7. Secure receiver chassis to receiver cabinet and tighten captive screws.
FROM NORMAL OPERATION TO STANDBY	1. Set OFF-STBY-ON Selector Switch from ON to STBY position. 2. Observe that POWER ON Indicator Lamp turns off. 3. Observe that POWER STBY Indicator Lamp turns on. 4. Observe that HIGH VOLTAGE ON Indicator Lamp turns off.
FROM STANDBY TO OFF (SECURE)	1. Set OFF-STBY-ON Selector Switch to OFF position 2. Observe that POWER ON or POWER STBY Indicator Lamps are off.

3-4. EMERGENCY OPERATION

When the TRACK/PWR LOSS lamp goes on during normal operation it indicates 1) complete power failure, or 2) that the PHASE LOCK is lost on at least one transmitting station. When phase lock is lost, the lane count has to be verified and reset after reacquiring phase lock.

3-5. OPERATOR'S MAINTENANCE

3-5-1. OPERATING CHECKS AND ADJUSTMENTS

During normal use, the only checks and adjustments performed by the operator are those outlined in paragraph 3-2-1. Operator's routine maintenance is limited to care of front panel controls and indicators. The operator should not attempt to perform any other maintenance.

3-5-2. PREVENTIVE MAINTENANCE

Periodically, the operator should run through a preventive maintenance procedure. This procedure should include the following:

1. The output of the dc voltage required to each of the four VCO's can be monitored on the test meter on the test panel on the OSC MON position.

2. The nominal operating point in the track mode should be set so that zero voltage is required for tracking. The normal phase locking procedure for reaching this zero point is given in Section 3-2-2-4-3. If this zero point is lost because of oscillator drift, follow the procedure in Section 3-2-2-4-4 (Oscillator Alignment) if proper equipment is available. Periodically, however, under the best conditions the necessary zero reading may be reached by adjustment of the screwdriver control on the oscillator units if proper phase locking exists.

3. The PHASE LOCK Indicator Lamps can be checked by depressing the LAMP TEST pushbutton.

3-5-3. EMERGENCY MAINTENANCE

Operator's maintenance is generally limited to replacement of blown fuses and defective indicator lamps.

Batteries, being of the sealed cadmium-nickel type, require little regular maintenance except that the charge be maintained. Batteries are enclosed in a case with a removable top so that they may be removed when they will no longer hold a charge. Batteries should never be overcharged or discharged at above normal rates. See section 1-3-1-10 for a discussion of the battery charging rates.

SECTION 4

TROUBLESHOOTING

4-1. LOGICAL TROUBLESHOOTING

Because adequate historical data for the Omega Navigation Receiver is not available, troubleshooting procedures are based on the following six logical steps. These steps are in a specific sequence, and no step should be excluded from the logical process of troubleshooting. As data become available, troubleshooting guides for localizing faults, giving the sources of trouble, the symptoms, and probable cause can be prepared to simplify the troubleshooting process.

4-1-1. SYMPTOM RECOGNITION

The first step in logical troubleshooting is symptom recognition, and it is based on a complete knowledge and understanding of the equipment operating characteristics. Because all equipment failures are not the direct result of a component failure, trouble in the equipment is not always easy to recognize since conditions of less than peak performance are not always apparent. The troubles usually can be corrected by adjustment and alignment procedures. When records of the adjustments and alignments are kept over a period of time, equipment operating trends become apparent and can be anticipated during the routine maintenance procedures, thus simplifying the procedures.

4-1-2. SYMPTOM ELABORATION

Once an equipment trouble has been recognized, all the available aids designed into the equipment should be used to further elaborate on the original trouble symptom. The use of front panel controls and the built-in indicating and testing aids should provide letter identification of the original trouble symptom. Possibly, the trouble may be eliminated by checking or manipulating the operating controls.

4-1-3. LISTING PROBABLE FAULTY FUNCTION

A tentative list of logical choices as to the cause of the fault and likely functional section at fault should be made. These choices are decisions based on a knowledge of equipment operation, a full identification of the trouble symptom, and information contained in this manual. The overall functional description, paragraph 4-2, and its associated system block diagram, figure 5-1, should be used when selecting possible faulty functional sections.

4-1-4. LOCALIZING THE FAULTY FUNCTION

The functional sections that have been chosen as likely to be faulty should be tested in an order that requires the least time. Which section to test first depends on the validity of the logical choice and the difficulties in making the necessary tests. If the tests do not prove that functional section be faulty, the next selection should be tested, and so on until the faulty functional section is located. As aids in this process, this manual contains a functional description and a system block diagram as well as functional section test procedures.

4-1-5. LOCALIZING TROUBLE TO THE CIRCUIT

When the faulty functional section is isolated, it is often necessary to make additional choices as to which circuit or group of circuits within the section is faulty. Since all but one functional section in Omega receiver contain a minimum number of circuits, the process of removal and replacement of

each circuit card in the section is the quickest means of locating the faulty circuit. Because a trouble in a functional section can be on more than one card, the recommended procedure for troubleshooting is to remove all the cards in the section and replace them with known good cards. Then retest the section to ensure that it is in fact the faulty functional section. After this is accomplished, sequentially remove and replace the known good cards with the cards previously removed, until the trouble reoccurs. After the trouble reoccurs, remove and replace the faulty card with a known good card and continue the sequential replacement of the remaining cards. After each removal and replacement of a card, the section must be tested to determine if that card is a faulty one. In addition to this, some cards are common to more than one section, and these sections should be tested to ensure that the new card does not introduce a fault into them. A list of the circuit cards and the functional sections in which they operate is presented in table 4-1.

4-1-6. FAILURE ANALYSIS

When the trouble has been located, but prior to performing corrective action, the procedures followed up to this point should be reviewed to determine why the fault affected the equipment in the manner it did. This review usually is necessary to make certain that the fault discovered is actually the cause of the malfunction, and not the result of the malfunction.

4-2. OVERALL FUNCTIONAL DESCRIPTION

The Omega Navigation Receiving System is made up of three interdependent units. These are: the Receiver, the Antenna, and the Graphic Recorder. Because the manufacturer's manual for the Graphic Recorder is included with the packaged recorder, a functional description of the recorder is not included in this section. The following paragraphs contain a description of how the receiver and antenna functionally

TABLE 4-1. CIRCUIT CARDS COMMON TO MORE THAN ONE FUNCTIONAL SECTION

CIRCUIT CARD NUMBER	FUNCTIONAL SECTION
1A1A2A12	Phase Converter and Driver - Lane 1
	Phase Converter and Driver - Lane 2
1A1A3A1	Signal Processor
	Phase Converter and Driver - Lane 1
1A1A3A2	Local Oscillator
	Test Signal Generator
	Phase Converter and Driver - Lane 2
1A1A3A3	Tracking Loops - Channel 1
	Channel 2
	Channel 3
	Channel 4
	Timing Network
1A1A3A4	Test Signal Generator
	Timing Network
1A1A3A6	Local Oscillator
	Timing Network

operate to produce accurate navigation data. This discussion is referenced to figure 5-1, System Functional Block Diagram.

An understanding of the Omega Navigation concept is basic to an understanding of the receiving system. A description of the concept is included in section 1, and should be referred to before attempting to understand the receiving system.

4-2-1. GENERAL DESCRIPTION

The receiving system antenna, a standard 10 foot whip with a frequency selective coupler, picks up the signals from the Omega transmitter, and the coupler couples signals at 10.2 and 13.6 kc, through a standard 95 ohm balanced line, to the receiver strip. The receiver strip functions as a basic superheterodyne receiver, except that it does not contain a local oscillator. And, additionally, the coupler input can be disconnected and a test signal substituted for processing by the receiver strip circuits. The receiver strip supplies inputs to both the signal processor and time synchronization indicator network. Also, an output of the receiver strip is available to the test oscilloscope. The signal processor provides both a data signal input and relay switching control inputs to the tracking loops as well as data signals to the time synchronization indication network and phase lock indication network. The time synchronization indication network, using the previously mentioned data inputs and synchronization gates from the timing network, generates and displays the information indicating that the receiving system timing is synchronous with the timing of the Omega Stations transmissions. The phase lock indicating network, also using previously mentioned data inputs and gating signals from the timing network, generates and displays the information indicating that the receiving system is phase locked to the transmissions of the Omega stations. The tracking loops (there are four: channels 1, 2, 3, and 4) further process the data signal input from the signal processor so that its outputs are, in effect, analogs of the received data. These analogs are further processed by the phase converters and drivers for lanes 1 and 2. This processing is such that lane count information can be displayed so that by comparison to Omega Navigation Charts the exact geographical position of the receiving system can be determined. Additionally, the outputs of tracking loop channel 1 are the basis for the receiving system timing as well as the data signal inputs to the local oscillator. The local oscillator provides the receiver strip with the correct local oscillator frequency for Omega station transmissions of either 10.2 or 13.6 kc. The timing and gating signals required by the receiving system are supplied by the timing network. In addition to its signal processing capability, the receiving system has a built in testing system and a removable (non essential to system operation) test oscilloscope, as well as power supplies that generate the correct dc voltages required by the receiving system. A more detailed description of data and control signal generation and flow is contained in paragraph 4-2-2.

4-2-2. DETAILED DESCRIPTION

The primary function of the receiver is to generate accurate lane counts. To do this, the receiver must accomplish two basic functions: phase lock and time synchronization. When this is done, the receiver then determines phase errors which it tracks. The tracked phase errors are used to produce the lane counts. The lane counts also include the percent of the lane that the receiver is in.

4-2-2-1. Phase lock and time synchronization are interdependent; one cannot occur without the other. These functions are accomplished in the signal processor. The signal processor receives the noncoherent envelope input from the receiver strip. This signal is applied to a quadrature phase detector and an in phase angle detector. These detectors also receive a reference input generated in the signal processor by a tuned isolation amplifier. The reference signal is a 17 kc square wave that is applied through a driver directly to the quadrature phase detector, and through a 90° phase shifter and driver to the in phase angle detector. The tuned isolation amplifier is enabled by the sequence of reference carrier processor signal from the switching matrix. This signal enables the amplifier to generate

the proper 17 kc reference signal at the correct time. This is accomplished by means of the long station gates and the 17 kc outputs of each tracking channel. The gates applied to the switching matrix are selected to be coincident with the selected transmitter station pulses by the station select switches. When phase lock and time synchronization are accomplished, by the manipulation of the controls, indications of these are available. The output of the in phase angle detector is the coherent envelope. When the generation of the 17 kc reference signal is coincident with the transmission of the station pulses both in time and phase, the coherent envelope and short station gates, applied to the phase lock indicating network, drive dc amplifiers that, in turn, drive the phase lock indicators. The indicator drive signals are summed along with the battery discharge alarm signal from the power supply, and are used to drive the track/power loss indicator. The coherent envelope and the sync gates combine to develop a drive signal for the sync meter. Actually, the envelope is applied to a low pass filter with a bandwidth of 5 cps and then to amplifiers and a phase splitter. The output of the phase splitter, a coherent positive envelope and a coherent negative envelope, are relay switched by the sync gates and applied to integrating amplifiers. The outputs of these amplifiers are switched by the sync indicator selector switch before being applied to the sync indication meter. The non-coherent envelope from the receiver strip also is applied to the time synchronization indicator network. This signal is applied to an envelope detector and the positive envelope is detected and applied to a low band pass filter with a 5 cps bandwidth. The output of this filter then is amplified and adjusted by the gain non-coherent envelope potentiometer. This non-coherent positive envelope or the coherent positive envelope previously mentioned, is selected by the coherent envelope/non-coherent envelope toggle switch and amplified before being transmitted to the test oscilloscope. Before the selected envelope is amplified it is transferred (in parallel with the amplifier) to the normal position of the timer test switch.

4-2-2-2. The receiver signal phase data output of the receiver processor is the output of the quadrature phase detector. This signal is the phase error, or difference in phase between the received transmitter station pulse and the reference signal output of the tuned isolation amplifier. If phase lock and time synchronization are not accomplished, the phase error will not be accurate. The short station gates applied to the signal processor are used to drive relay drivers. The sequence of channel sampled data control output of the signal processor is the outputs of the relay drivers. These two signals, the phase data and sequence control, are applied to each of the tracking channels.

4-2-2-3. Tracking channel 1, of the four channels, is the primary channel. Its output of 17 kc is the only data input to the timing network and its 816 and 272 kc outputs are the only data inputs to the local oscillator. For these reasons, channel 1 is tuned to the strongest available transmitting station. Since all of the channels function in the same manner, only channel 1 is discussed here. The sequence of channel sampled data control signal will energize a relay each time the short station gate is generated for the station to which channel 1 is tuned. This enables the phase data signal to be applied to a tracking loop filter. The filter also incorporates an integrating operational amplifier that, in turn, drives the voltage controlled oscillator. For tuning and testing purposes, the VCO can be slewed above and below its normal operating frequency by use of the VCO lock/search and oscillator monitor switches. Functionally, the oscillator remembers each input and changes its output to correspond to the difference in inputs. Therefore, it tracks the inputs which are the phase errors from the signal processor. The 816 and 272 kc outputs of channel 1 are supplied to the local oscillator where one or the other is appropriately reduced by division to supply the mixer stage of the receiver strip with a local oscillator frequency of either 30.6 or 27.2 kc. The selection of the frequency for reduction is accomplished by the frequency switch. This switch supplies a frequency select relay control signal to the local oscillator.

4-2-2-4. The 17 kc output of each channel is supplied to both readout selector switches. These switches are used to select which pair.

of channels are to be compared to determine the position of the receiver on a hyperbolic line of position. Since the channels are turned to separate stations, the receiver is actually located at some point on a hyperbolic line of position between two stations. If readout 1 is set at position 1-2, and channel 1 is tuned to station A and channel 2 is tuned to station D, the receiver is somewhere on the line of position between stations A and D. The 17 kc output of channel 1 is actually an analog of the receiver's distance from station A and the 17 kc output of channel 2 is actually an analog of the receiver's distance from station D. The phase converter that these two analogs are applied to, converts this information into the receiver's position on the hyperbolic line of position. This information is continually integrated to compensate for positive and negative movement of the receiver on the line of position. The position information also is applied to polarity sensors in the lane drivers. These drivers drive the lane counters up or down depending on the sensed polarity of the position information signal.

4-2-2-5. The 17 kc output of channel 1 is applied to the timing network. This is a digital section that develops the long and short station gates and sync gates, as well as a reference pulse, a 10 pps signal, and a control signal for the electronic switch in the test oscilloscope. A logic diagram of the timing network and a schematic diagram of the test oscilloscope are included in section 5.

4-2-2-6. The gates from the timing network and the envelope from the time synchronization indicating network can be displayed on the graphic recorder by the proper manipulation of the timer test and recorder select switches. Also, the reference pulse from the timing network can be displayed on the graphic recorder via the recorder select switch.

4-2-2-7. The test signal generator supplies the receiver strip with a test signal for processing. This is accomplished by selecting the 816 kc output of one of the channels as a signal input to the test signal generator by means of the receiver test select switch. The 816 kc signal selected is reduced by division to 20.4 and 27.2 kc. The position of the frequency switch determines which of these signals will be further reduced by division to either 10.2 or 13.6 kc. The test signal can be tested by means of the test meter. However, the test signal cannot be applied to the receiver strip unless one of the four station test switches is in the test position.

4-3. FUNCTIONAL SECTION DESCRIPTION

The following paragraphs contain descriptions of the operation of each functional section and functional section tests.

4-3-1. RECEIVER STRIP

The receiver strip consists of the input transformer, preselector stages, mixer, and 17 kc amplifier. In all, 18 stages are located on eight printed circuit cards. These cards are numbered 1A1A1A1 through 1A1A1A8. The receiver strip functions as a superheterodyne with an external local oscillator. The only direct method of testing the receiver strip is to view the noncoherent envelope output on the test oscilloscope. Also, the limiter output of the receiver strip can be viewed on the oscilloscope. When a trouble has been localized to the receiver strip, a test signal can be inserted. By inserting the test signal and viewing the receiver strip output on the test scope one can determine whether or not the trouble lies in the input stage or in the succeeding stages. If the trouble lies in the succeeding stages, the output of the mixer can be tested by inserting card 1A1A1A4 in the extender card and observing the output in pin 17. This is shown on figure 5-10. If this output is not faulty, the trouble is in cards 1A1A1A5 through 1A1A1A8. If the output of the mixer is faulty, the trouble is in cards 1A1A1A1 through 1A1A1A4. Once the trouble has been localized to a group of four cards, use the procedures outlined in paragraph 4-1-5 to find the faulty card.

4-3-2. SIGNAL PROCESSOR

The signal processor consists of cards 1A1A2A1, 1A1A2A2, 1A1A2A7, and 1A2A2A9. A functional description of the signal processor is contained in paragraph 4-2. When a fault has been localized to the signal processor use the troubleshooting procedure contained in paragraph 4-1-5 to localize the faulty card.

No direct method of testing the signal processor is available using the test panel.

4-3-3. TRACKING LOOPS

The tracking loops are composed of channels 1, 2, 3, and 4. A functional description of these is included in paragraph 4-2. Channel 1 is composed of the following cards; 1A1A9, 1A1Y2, and 1A1A3A3. Channel 3 is composed of the following cards; 1A1A10, 1A1Y3, and 1A1A3A3. Channel 4 is composed of the following cards; 1A1A11, 1A1Y4, and 1A1A3A3. When a trouble has been localized to one of the channels, use the troubleshooting procedures outlined in paragraph 4-1-5. All of the channels are tested in the same manner so the test procedures for channel 1 can be applied to channels 2, 3, and 4. The 17 kc output is tested by placing the test meter switch in the numbered position in the tracker section that corresponds to the channel number. The test meter indicator should deflect to the green area on the positive side of the scale. The memory capability of each channel can be tested by placing the external sync/memory switch to the memory position and monitoring the 17 kc output. The oscillator memory test also requires that the receiver test select switch be in the appropriate channel position. The tracking loop filters, 1A1A8, 1A1A9, 1A1A10, and 1A1A11, can be tested by placing the oscillator monitor switch to the appropriate channel number position and slewing the oscillator by means of the VCO lock/acquire switch. To test the channels, place the VCO lock/acquire switch in the high position and observe that the test meter oscillations slow down and stop when the channel bucks out the slew signal. Place the VCO lock/acquire switch in the low position and observe the same result on the test meter.

4-3-4. TIMING NETWORK

The outputs of the timing network, the gates, and the envelope output of the time synchronization indicator network can be tested by means of the timer test switch. To do this, the recorder select switch should be in the align position and the timer test switch rotated through its successive positions. The gates will be displayed on the graphic recorder. The timing network is composed of cards 1A1A3A1 through 1A1A3A8. This test also tests a portion of the phase converter and the reference signal output of the timing network. The phase converters are cards 1A1A3A1 for lane 1 and 1A1A3A2 for lane 2. A functional description of the phase converters is included in paragraph 4-2. A logic diagram of the timing network is included in section 5, figure 5-2.

4-3-5. TEST SIGNAL GENERATOR

The test signal generator is composed of cards 1A1A3A1, 1A1A3A2, and 1A1A3A4. A functional description of the test signal generator is included in paragraph 4-2-2-7. The output of the test signal generator can be tested by use of the test meter switch. By placing this switch in the test generator position, the test signal is applied to the test meter. The meter indicator should deflect to the green area of the positive portion of the scale.

4-3-6. PHASE LOCK INDICATION NETWORK

The phase lock indication network can be tested by the lamp test pushbutton on the front panel. This network is composed of cards 1A1A2A6 and 1A1A2A8. A functional description of this section is included in paragraph 4-2.

4-3-7. TIME SYNCHRONIZATION NETWORK

This network is composed of cards 1A1A2A3, 1A1A2A4, and 1A1A2A5. A functional description of this section is contained in paragraph 4-2. The envelope output can be displayed on the graphic recorder by the timer test switch in the normal position and the recorder select switch in the align position. This envelope also can be viewed on the test oscilloscope by using the envelope/timer test test point on the test panel.

4-3-8. LOCAL OSCILLATOR

The local oscillator is composed of cards 1A1A3A2 and 1A1A3A6. A functional description of this section is included in paragraph 4-2-2-3. No direct method of testing

the local oscillator using the test panel is available.

4-3-9. POWER SUPPLY

The power supply is composed of 1A1A5, 1A1A6, the battery pack and the battery discharge alarm circuit. The outputs of the power supply can be tested by the test meter switch. The switch positions marked +24, +20, +15, and -15 correspond to the outputs of 1A1A5. In each of these positions, the meter indicator should deflect to the appropriate (+ or -) green area of the meter scale. The switch positions marked +26, +20 OSC, +4.5, and -2 correspond to the outputs of 1A1A6. The meter should react in the manner just described. The battery is automatically monitored by its alarm circuit. If the battery voltage falls below a prescribed level, the track/power loss indicator will turn on. See paragraph 1-3-1-10 for a discussion of power supply battery charging characteristics and Operator's duty in switching to full charge after battery use.

SECTION 5

REPAIR

5-1. FAILURE, AND PERFORMANCE AND OPERATIONAL REPORTS

The Bureau of Ships no longer requires the submission of failure reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipments (refer to Electronics Installation and Maintenance Book, NAVSHIPS 900,000) only to the extent required by existing directives. All failures shall be reported for those equipments requiring the use of Failure Reports.

5-2. PREVENTIVE MAINTENANCE

The Omega Navigational Receiver requires no external test equipment or special tools. The receiver has a built in test set and a removable test oscilloscope. The test procedures for the receiving set are included in section 4. After correcting a system fault by replacing the faulty circuit card, as detailed in section 4, the faulty card should be carefully packaged and returned to the factory for repair. No attempt to repair the faulty card should be made aboard ship.

5-2-1. Preventive maintenance testing of the equipment should be accomplished only when the equipment is in the standby mode of operation. Preventive maintenance tests can be made using the built in test set. The procedures for using the test set are outlined in section 4.

5-2-2. When it is desired to test an individual circuit board an extender card must be used. The digital section has its own circuit extender board, since these boards are larger than the rest of the boards in the receiver set. The extender board for all other circuit cards is located in the analog section. To use the extender boards, remove the circuit card to be tested and insert the extender card in the jack. The top of the extender card has a jack with two plastic inserts. These should be set into the jack in positions that correspond to the slots at the plug end of the circuit card to be tested before inserting the circuit card into the extender board jack. The circuit boards and extender cards are held in place in their slots by cam locks. To remove the cards, lift up on the cam locks and the card will pop up, out of the jack. To replace the card, push down and the cam locks will snap the card into the jack and lock it.

5-3. REPAIR

The following paragraphs contain information on the removal and replacement of the pull-out drawer and the pivoting of the pull-out drawer.

5-3-1. REMOVAL AND REPLACEMENT OF PULL-OUT DRAWER

Removal - To remove the pull-out drawer, proceed as follows:

1. Loosen all captive screws approximately 5-1/2 turns until the captive screw shaft extends to its extreme length.

2. Pull out drawer by the handles until each slide locks.

3. Depress latches on each slide and pull out drawer by the handles.

Replacement - To replace the pull-out drawer, proceed as follows:

1. Insert the slides into the runners and push forward on drawer until the latches lock.

2. Depress latches and push forward on

drawer until the drawer is closed.

3. Tighten captive screws by turning clockwise approximately 5-1/2 turns.

5-3-2. PIVOTING OF PULL-OUT DRAWER

Elevate - To elevate the pull-out drawer for servicing, proceed as follows:

1. Repeat steps 1 and 2 of paragraph 5-3-1.

2. Pull handles on each slide and push down on drawer. Handles will release when drawer is in 90-degree position.

Restore - To restore the pull-out drawer to normal position, proceed as follows:

1. Pull handles on each slide and pull up drawer to horizontal position where handles will release.

2. To replace drawer, repeat steps 2 and 3 of paragraph 5-3-2.

5-4. POWER DISTRIBUTION

The point-to-point wiring for power distribution is included in Table 5-1.

5-5. PARTS LOCATION DIAGRAMS

The parts location diagrams included in this section pertain to eight assemblies and 35 circuit cards. The circuit card parts location diagrams have test point and wave shape information on them, in addition to parts location information. The test point and wave shape information is provided as a double check of a suspected faulty card. By inserting a card in the extender board and verifying the test point and wave shape information, it is possible to accurately determine whether the circuit is faulty.

TABLE 5-1. POWER DISTRIBUTION

- 1A1A5-1, 2 Prime Power 115V 60 cps
  - -3 case ground
  - -4 — 24V RETURN
    - E7 — 1A1A3J6-61
      - 1A1A3J1-7
      - 1A1A2J9-5
      - 1A1A11-7 - 1A1A10-7 - 1A1A9-7 - 1A1A9-7
      - 1A1S12-C - 1A1S13-A1
  - -7 — +24V Relay Supply
    - 1A1A2J12-11 — 1A1A2J4-11
      - 1A1A2J6-11
    - E6 — 1A1A3J4-41
      - 1A1A1J1-A
      - 1A1A4J10-79
      - 1A1A11-5 - 1A1A10-5 - 1A1A9-5 - 1A1A8-5
      - 1A1S13-A2 — 1A1S13-BA
        - 1A1TB2-3 — 1A1MP2+
          - 1A1MP2-
          - 1A1TB1-3 — 1A1MP1+
            - 1A1MP1-

TABLE 5-1. POWER DISTRIBUTION (continued)

1A1A5-5 — +20V
- E5 — 1A1A1J1-B
  - 1A1A4J10-27
  - 1A1A3J1-67 - 1A1A3J2-67
  - 1A1A2J2-13 — 1A1A2J8-13
    - 1A1A2J7-13 - 1A1A2J1-13

-6 — +15
- E4 — 1A1A2J5-17
  - 1A1A4J10-24
  - 1A1A3J1-49 - 1A1A3J2-49
  - 1A1A11-2 - 1A1A10-2 - 1A1A9-2 - 1A1A8-2

-10 — -15V
- 1A1Y1-8 - 1A1Y2-8 - 1A1Y3-8 - 1A1Y4-8
- E10 — 1A1A1J1-E
  - 1A1A4J10-26
  - 1A1A3J1-45
  - 1A1A2J5-15 - 1A1A2J3-17 - 1A1A2J8-17
  - 1A1Y1-8 - 1A1Y2-8 - 1A1Y3-8 - 1A1Y4-8

-8 — DC NEUTRAL
- E8 — 1A1A1J1-C
  - 1A1A3A1-71 - 1A1A3A2-71 - 1A1A3A3-35 - 1A1A3A4-35 - 1A1A3A5-35 - 1A1A3A6-35 - 1A1A3A7-35 - 1A1A3A8-35
  - 1A1S10-D & C — 1A1S14 - D & C
    - 1A1S12 - AA & B1 & B3 & B5

-9 — DC NEUTRAL
- E9 — 1A1K1-X2
  - 1A1S18-A - 1A1S19-A - 1A1S20-A - 1A1S21-A
  - 1A1A11-8 - 1A1A10-8 - 1A1A9-8 - 1A1A8-8
  - 1A1A2J12-29 - 1A1A2J6-29 - 1A1A2J5-29 - 1A1A2J4-29 - 1A1A2J3-29 - 1A1A2J2-25 - 1A1A2J1-25 - 1A1A2J8-29 - 1A1A2J8-12 - 1A1A2J7-25

1A1A6-1, 2 PRIME POWER 115V 60 cps

-3 — +26V oven supply
- 1A1A4J10-23
- 1A1DS1-2
- 1A1Y4-1 - 1A1Y3-1 - 1A1Y2-1 - 1A1Y1-1

TABLE 5-1. POWER DISTRIBUTION (continued)

- 1A1A6-4 (-) oven supply
  - 1A1DS1-3
  - 1A1Y4-3 - 1A1Y3-3 - 1A1Y2-3 - 1A1Y1-3
- -5 +20V oscillator supply
  - 1A1A4J10-28
  - 1A1Y4-4 - 1A1Y3-4 - 1A1Y2-4 - 1A1Y1-4
- -6 +4.5V
  - 1A1A4J10-21
  - 1A1A2J12-19 - 1A1A2J6-19 - 1A1A2J4-19 - 1A1A2J9-19
  - 1A1A3J1-41 - 1A1A3J1-63 - 1A1A3J2-41 - 1A1A3J3-31 - 1A1A3J4-31 - 1A1A3J5-31 - 1A1A3J6-31 - 1A1A3J7-31 - 1A1A3J8-31
- -7 -2.0V
  - 1A1A4J10-30
  - 1A1S2-N02 - TA1DS5-5
  - 1A1A2J12-9 - 1A1A2J6-9 - 1A1A2J4-9 - 1A1A2J9-9
  - 1A1A3J1-57 - 1A1A3J2-57 - 1A1A3J3-39 - 1A1A3J4-39 - 1A1A3J5-39 - 1A1A3J6-39 - 1A1A3J7-39 - 1A1A3J8-39
- -8 DC NEUTRAL
  - 1A1A5-8
  - 1A1S15-CA - 1A1M3(-)
  - E11
    - 1A1J9-3
    - 1A1A4J10-29
    - 1A1Y4-6 - 1A1Y3-6 - 1A1Y2-6 - 1A1Y1-6
- -9 Battery + Input
- -10 Battery Signal
  - 1A1A2J8-23

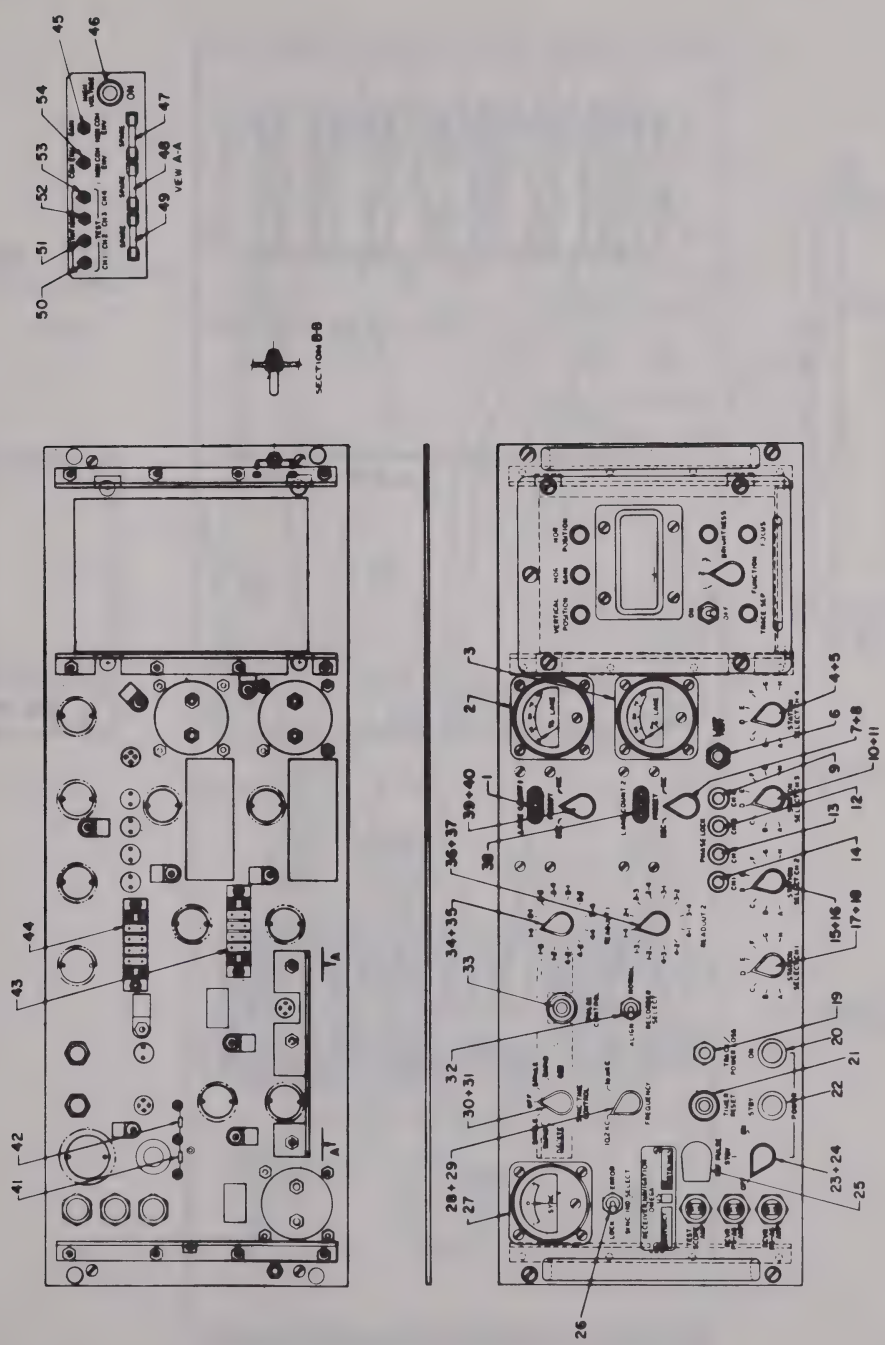


Figure 5-1. Receiver Control Panel Assembly Drawing

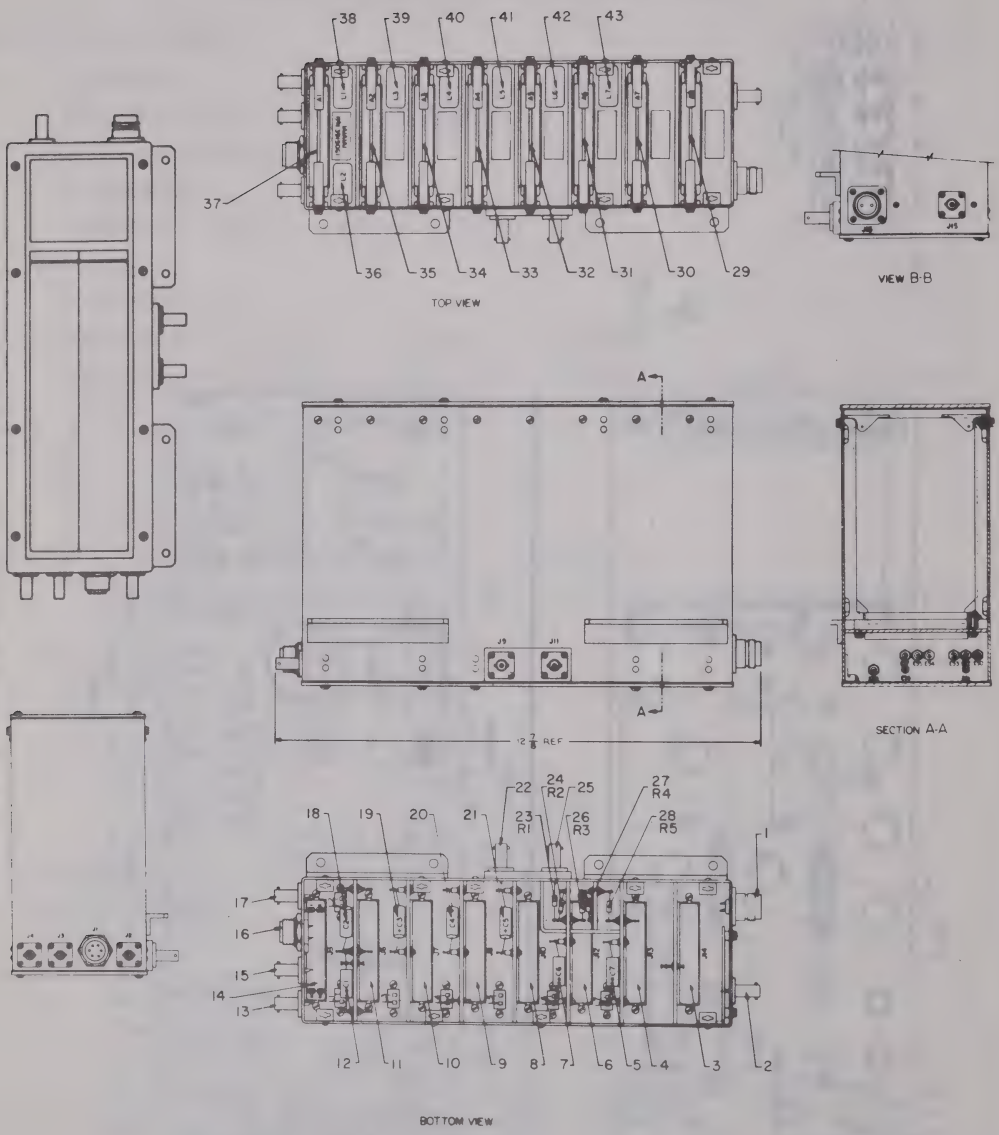


Figure 5-2. Receiver Strip Assembly Diagram

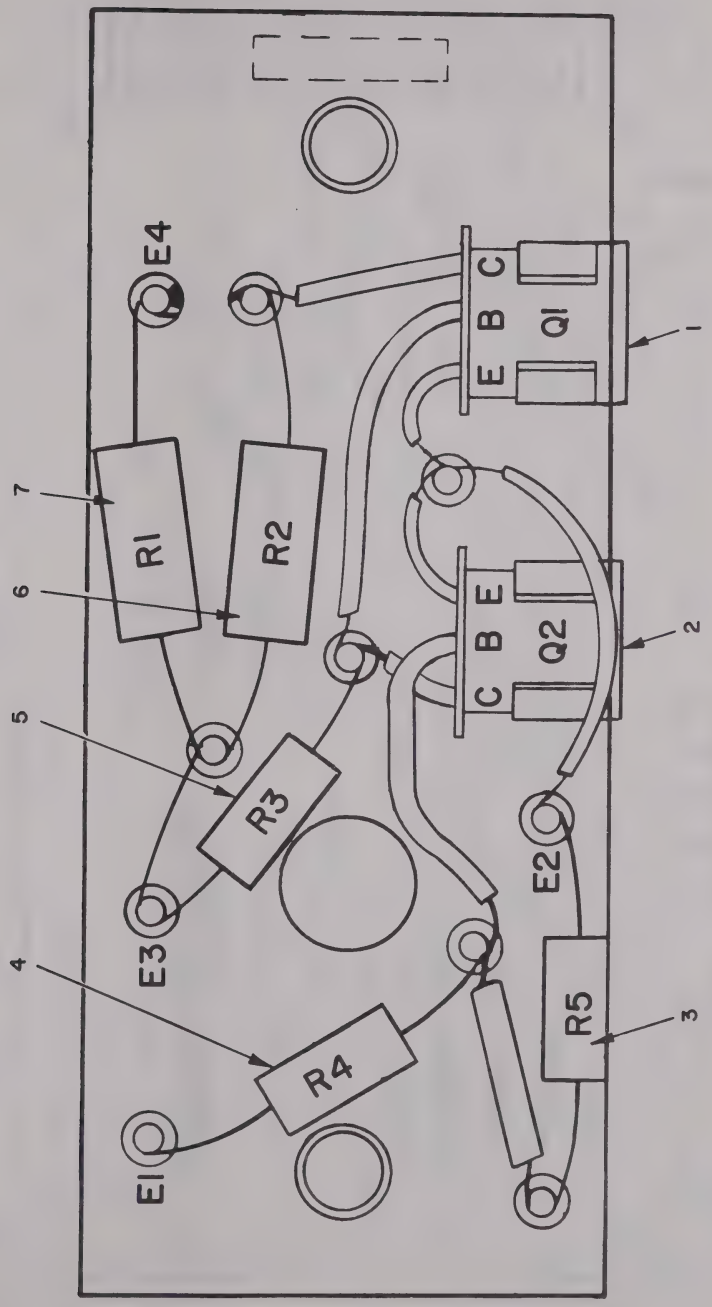


Figure 5-3. Relay Driver Assembly Diagram

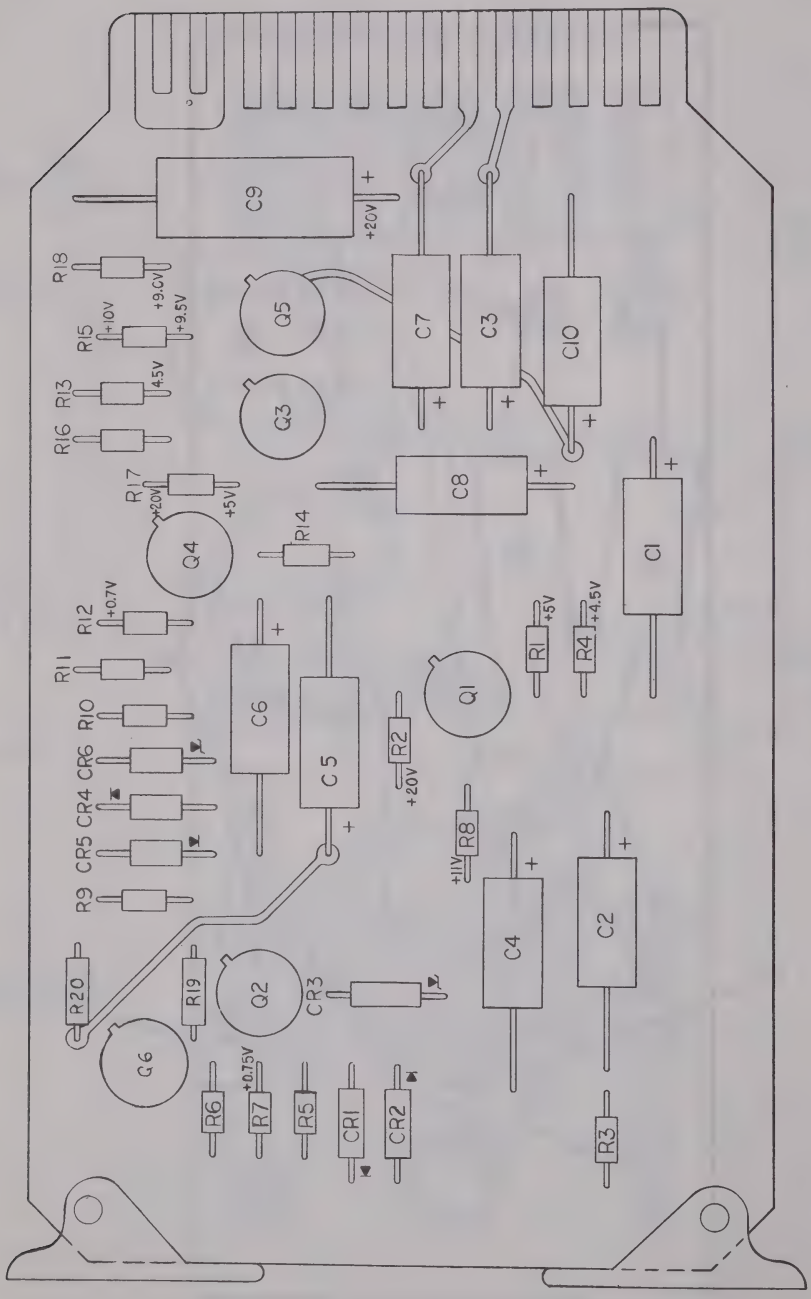


Figure 5-4. Second IF Limiter Parts Location Diagram, 1A1A1A1

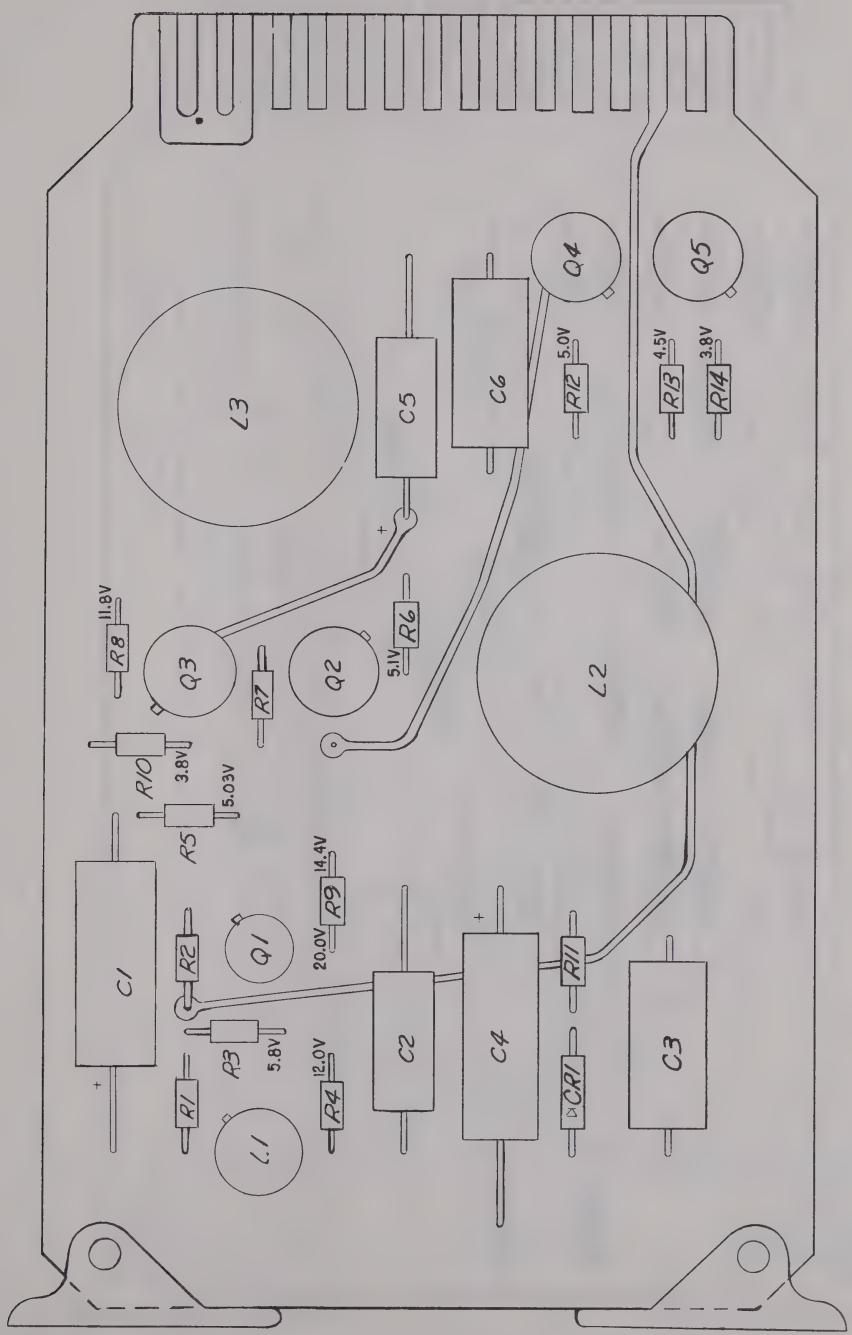


Figure 5-5. 100 Cycle Filter Parts Location Diagram, 1A1A1A2

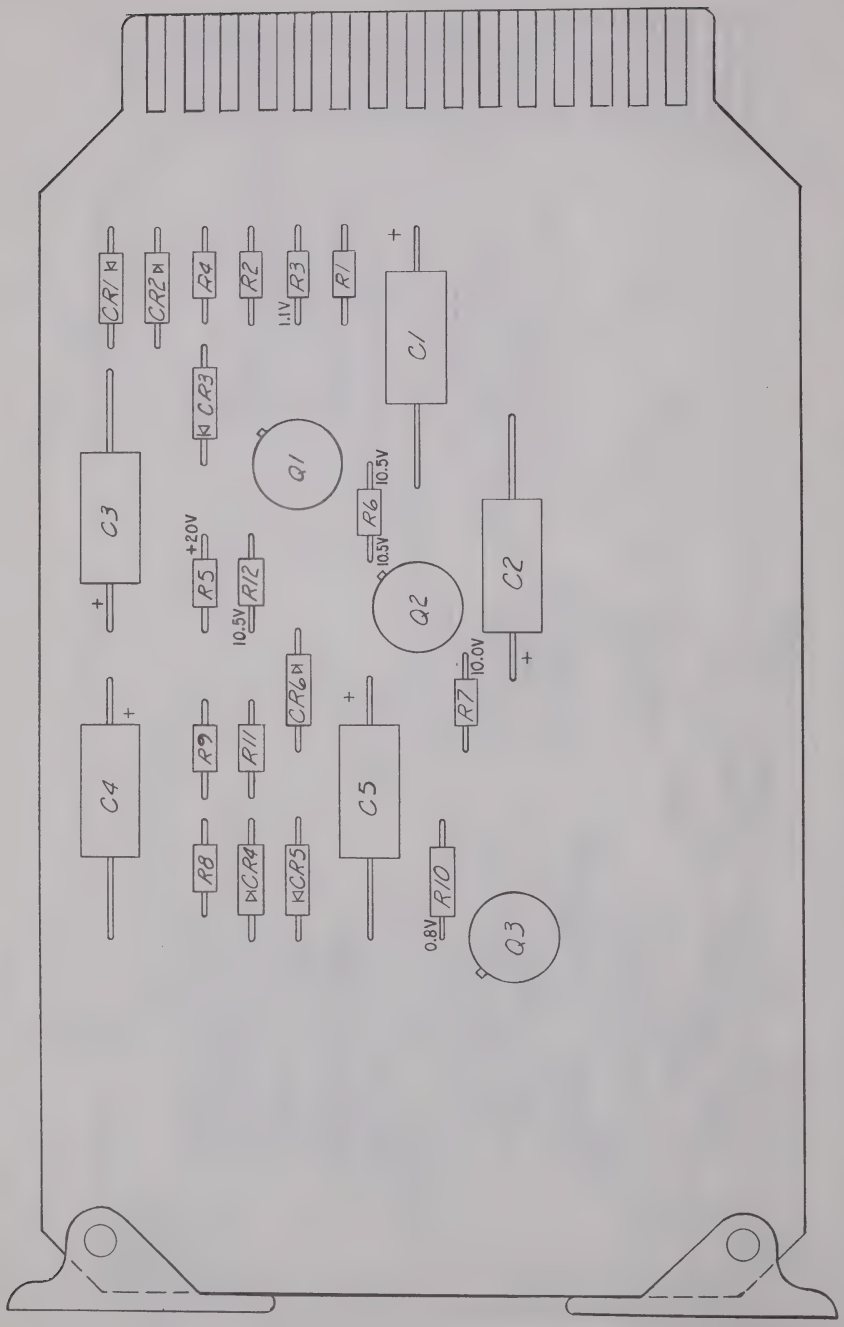


Figure 5-6. First IF Limiter Parts Location Diagram, 1A1A1A3

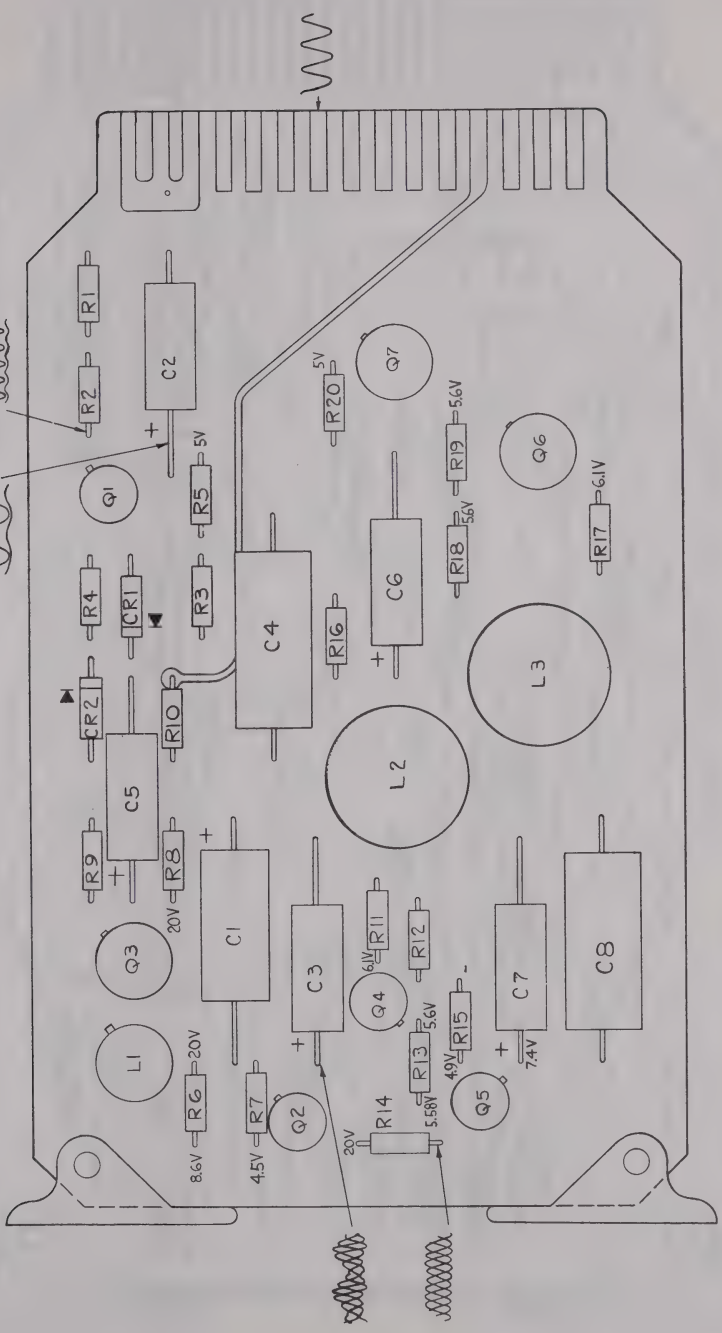


Figure 5-7. Mixer Amplifier Parts Location Diagram, 1A1A1A4

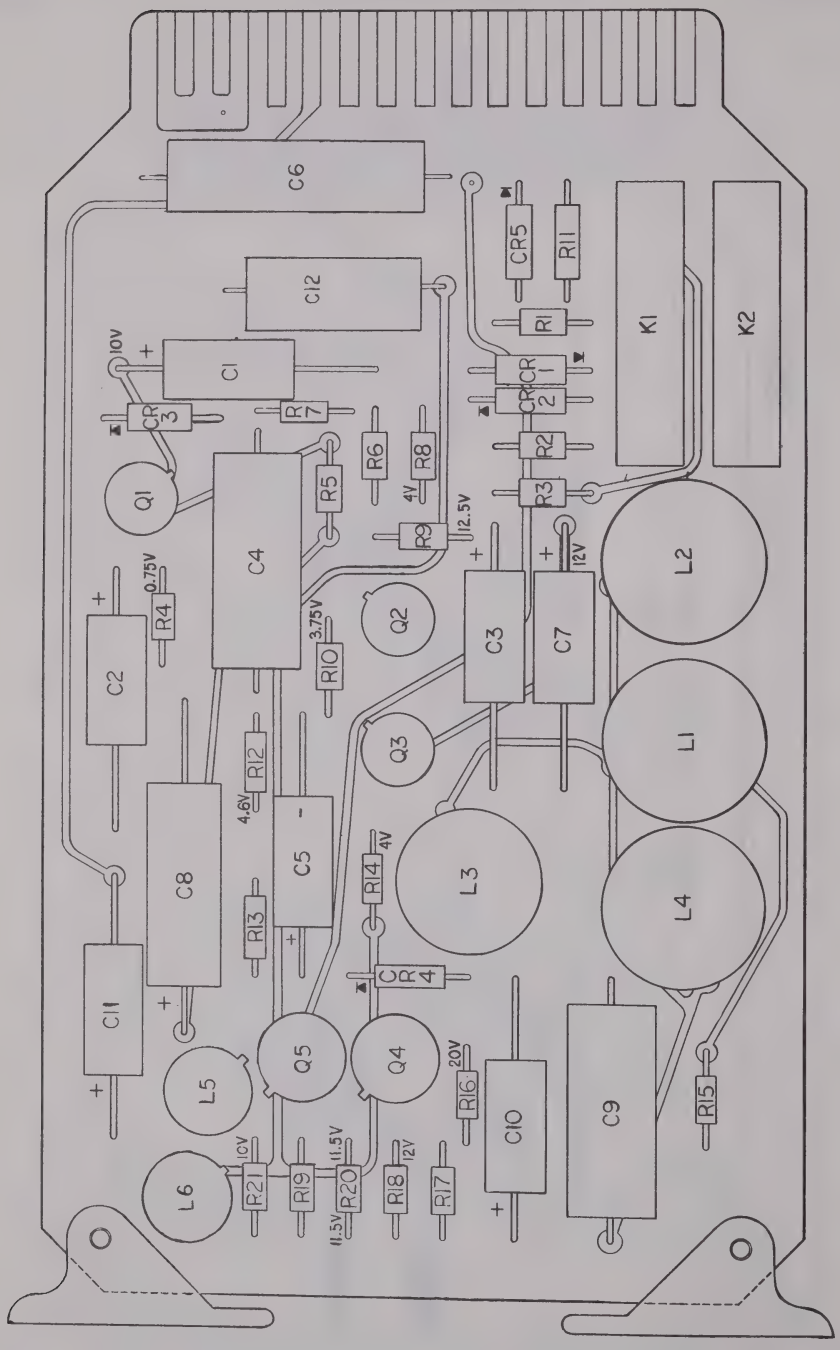


Figure 5-8. Third 10.2 and 13.6 Filter Parts Location Diagram, 1A1A15

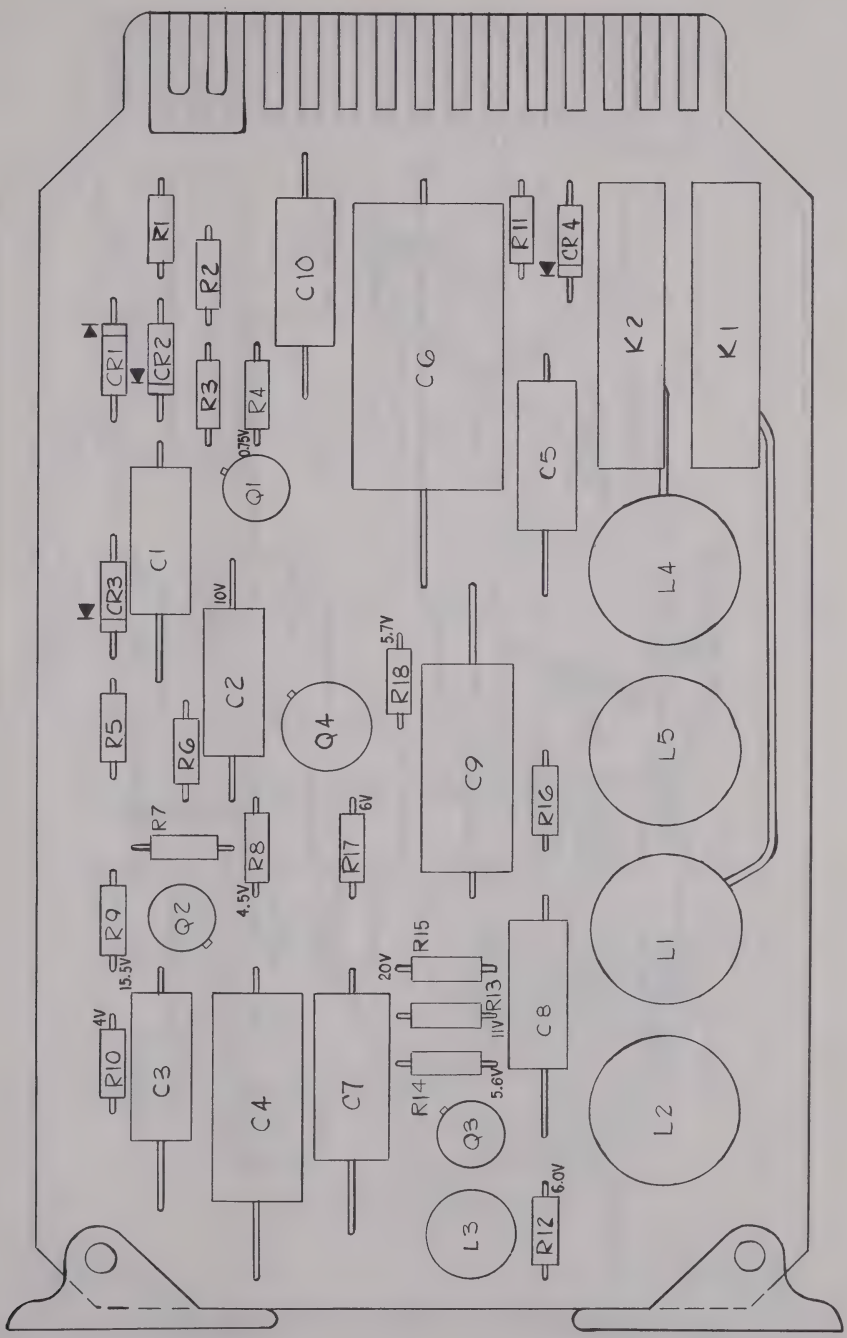


Figure 5-9. Second 10.2 and 13.6 Filter Parts Location Diagram, 1A1A1A6

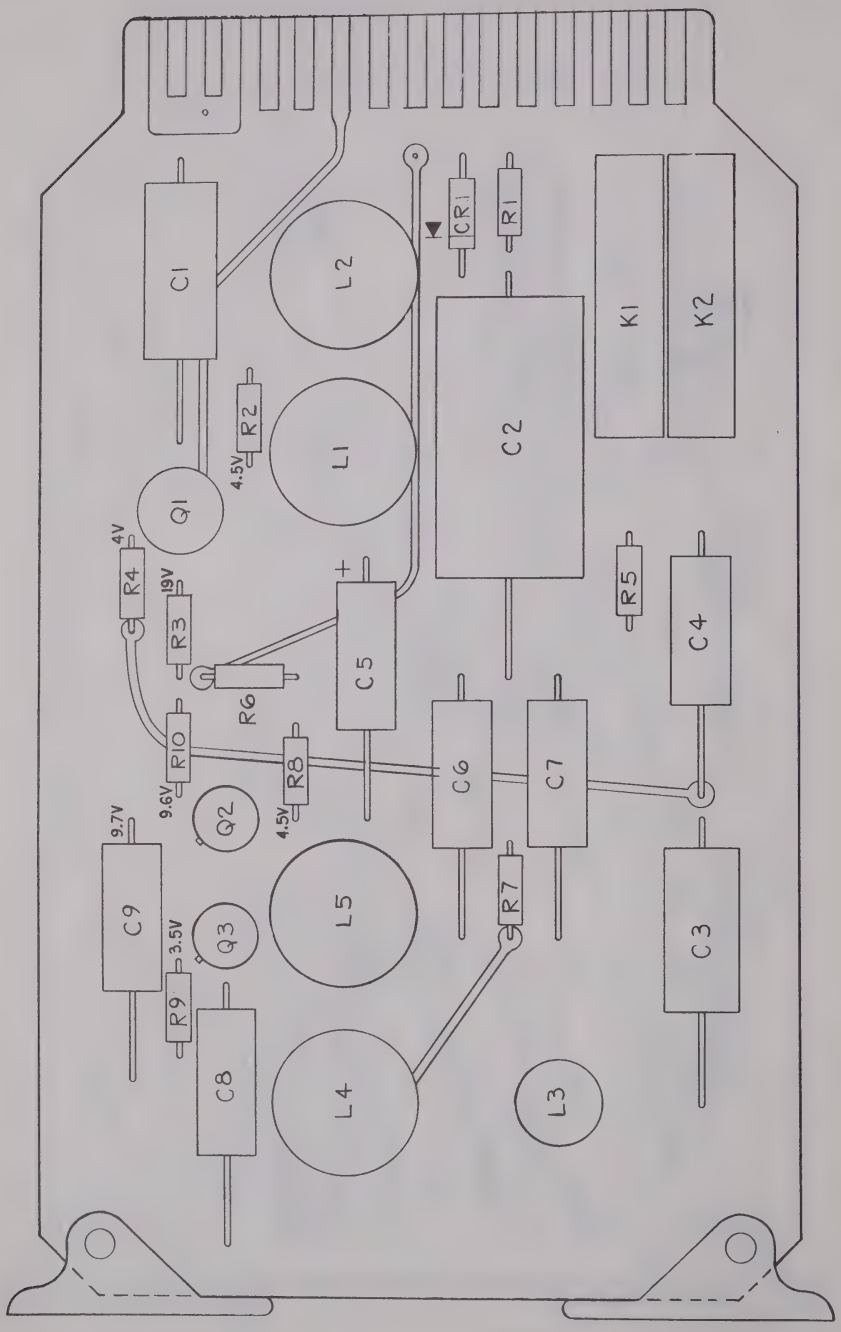


Figure 5-10. First 10.2 and 13.6 Filter Parts Location Diagram, 1A1A1A7

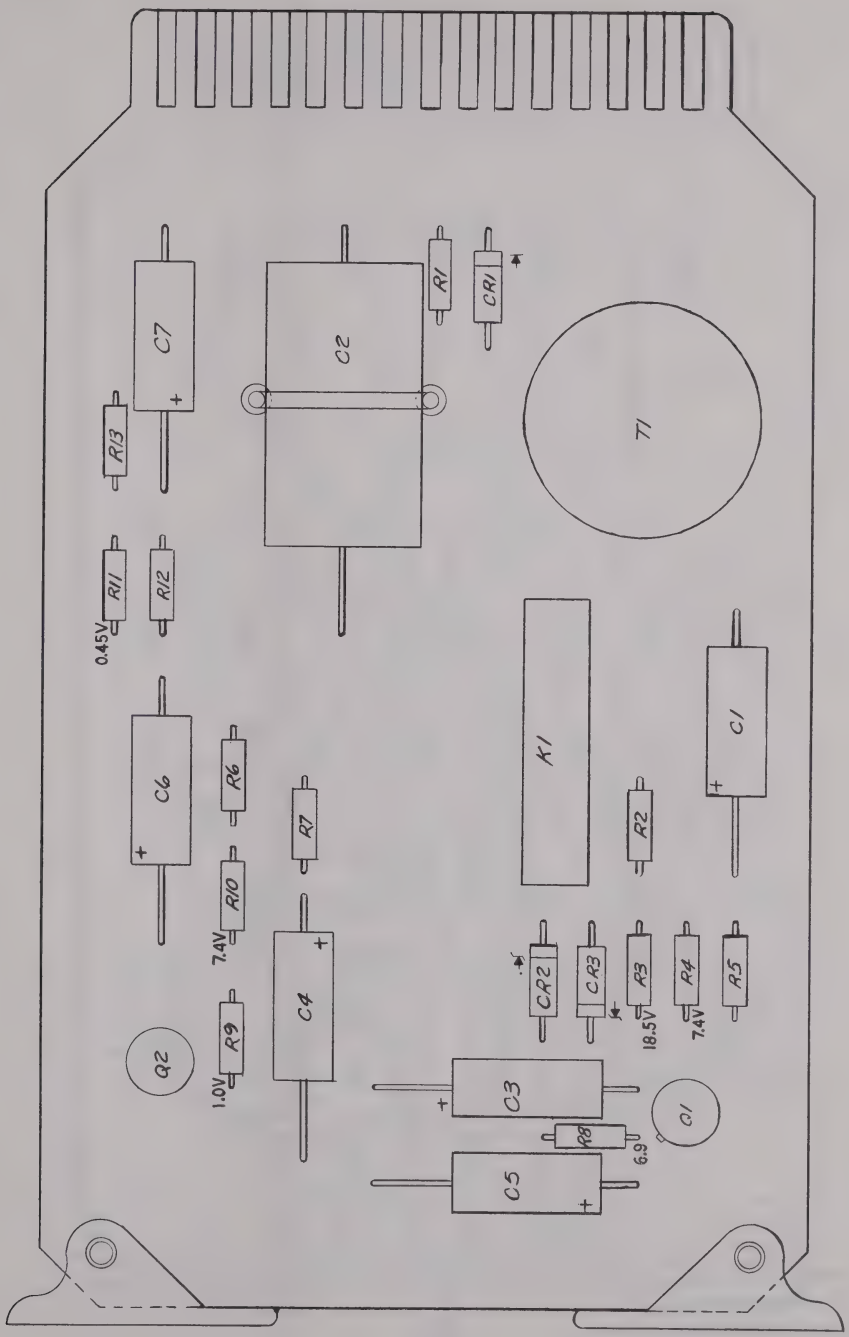


Figure 5-11. Input Amplifier Parts Location Diagram, 1A1A1A8

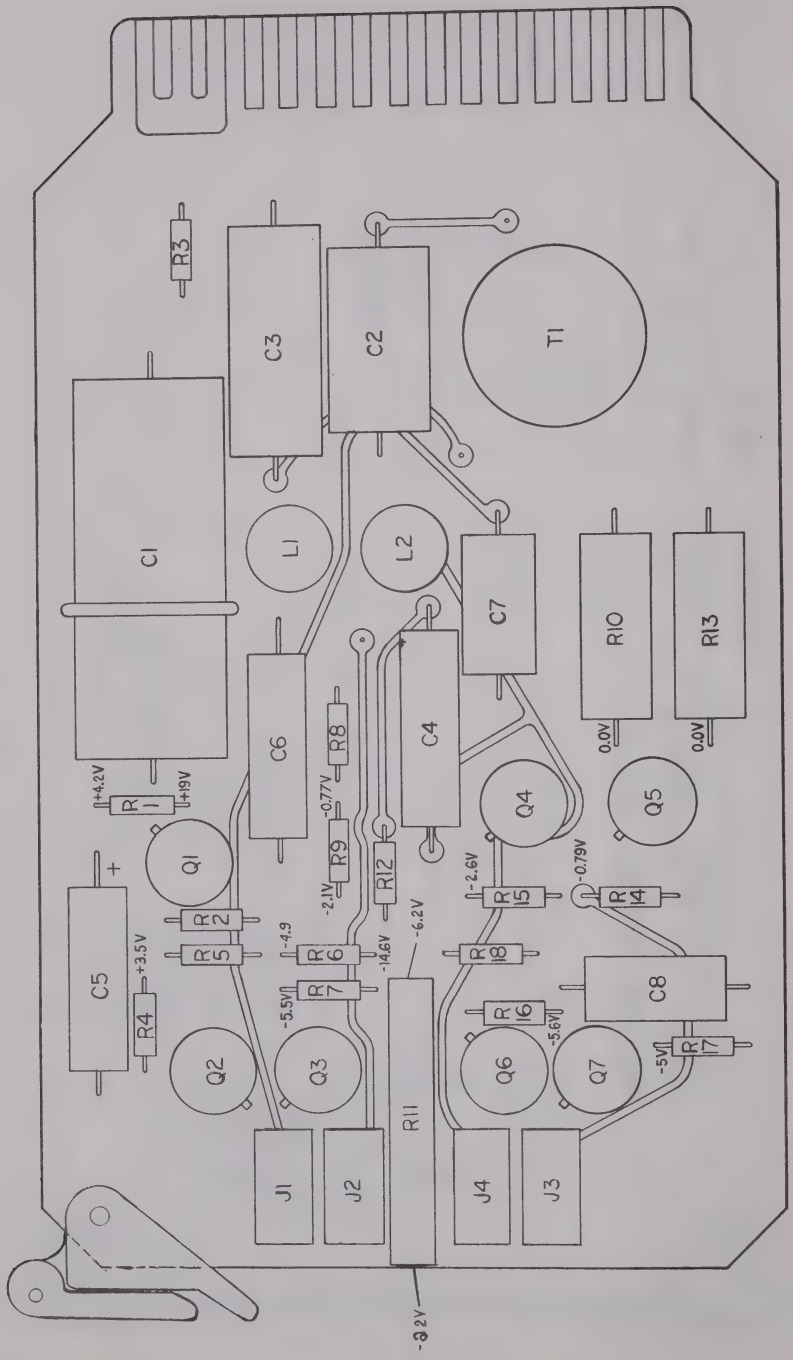


Figure 5-12. Phase Detector Parts Location Diagram, 1A1A2A1

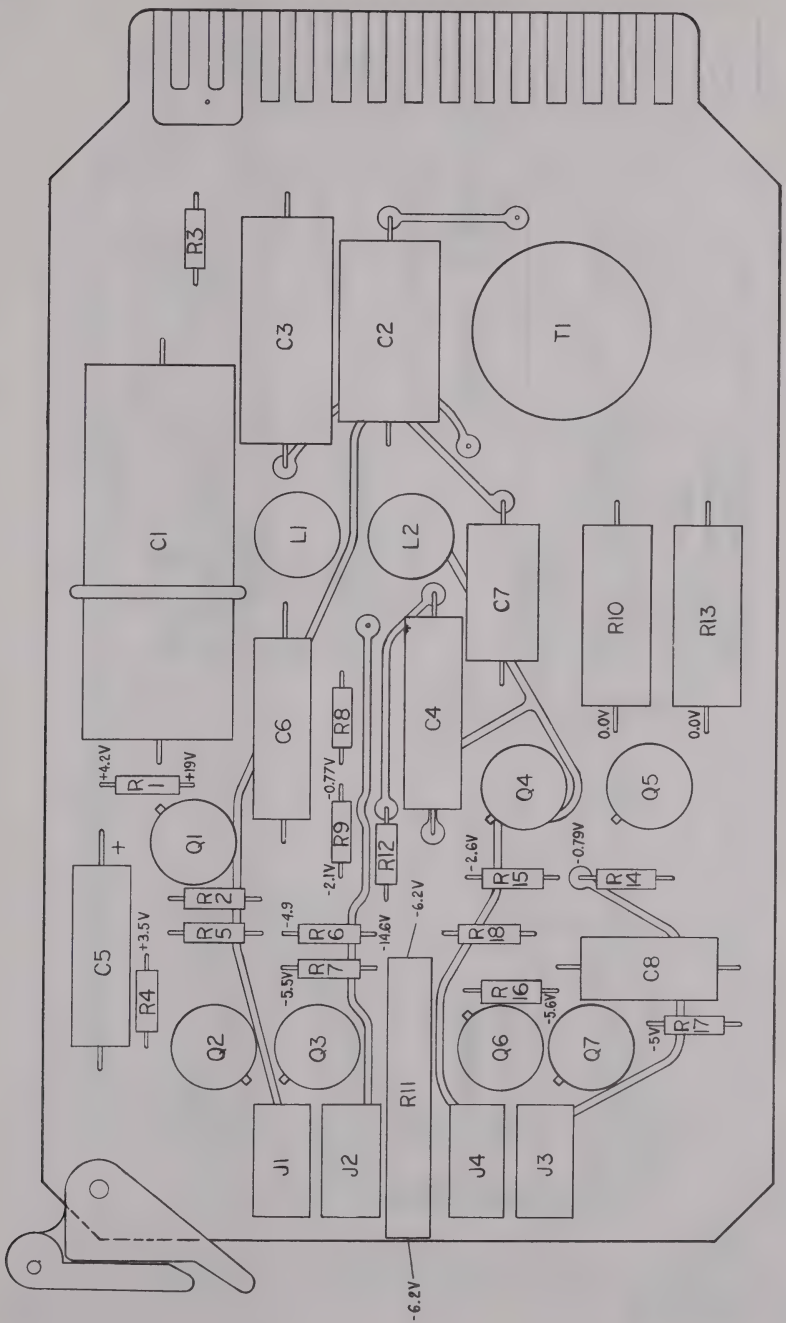


Figure 5-13. Phase Detector Parts Location Diagram, 1A1A2A2

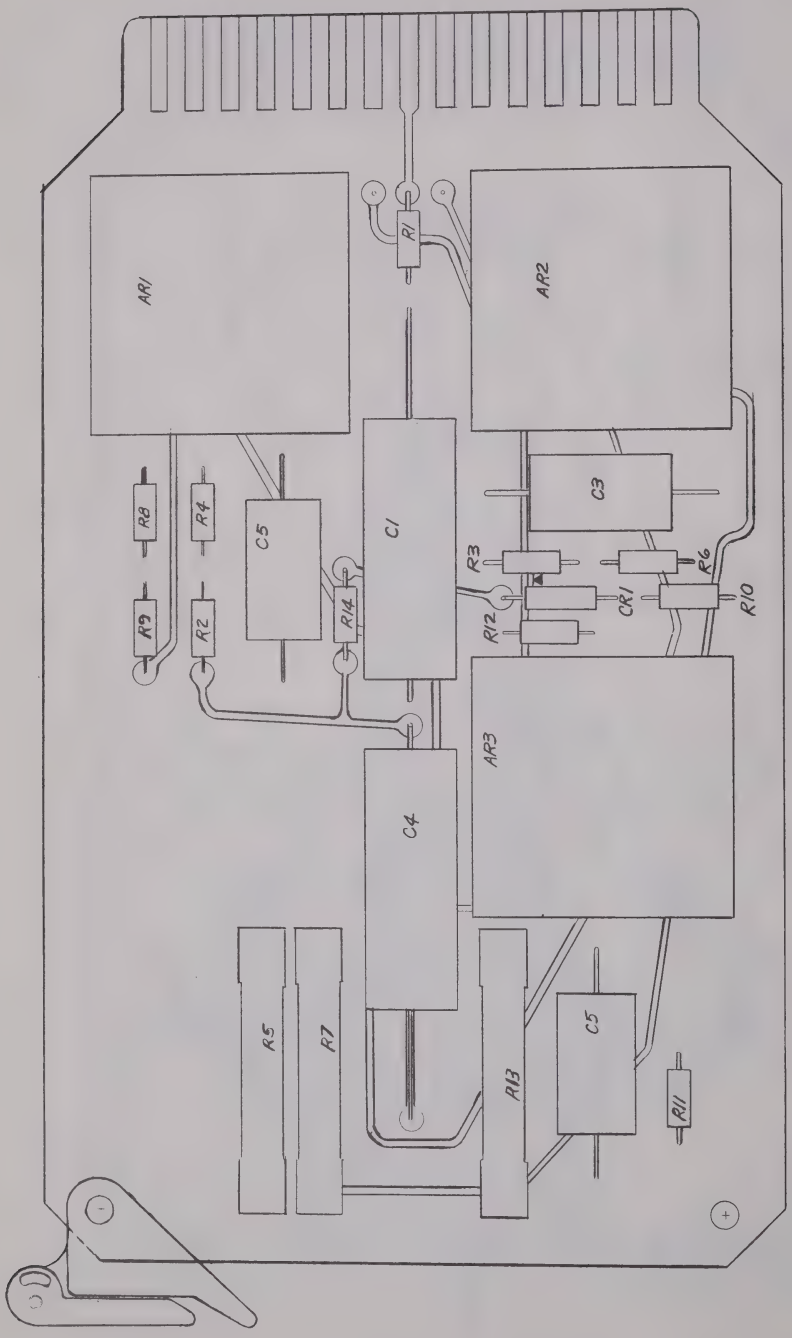


Figure 5-14. Phase Splitter and Envelope Detector Parts Location Diagram, 1A1A2A3

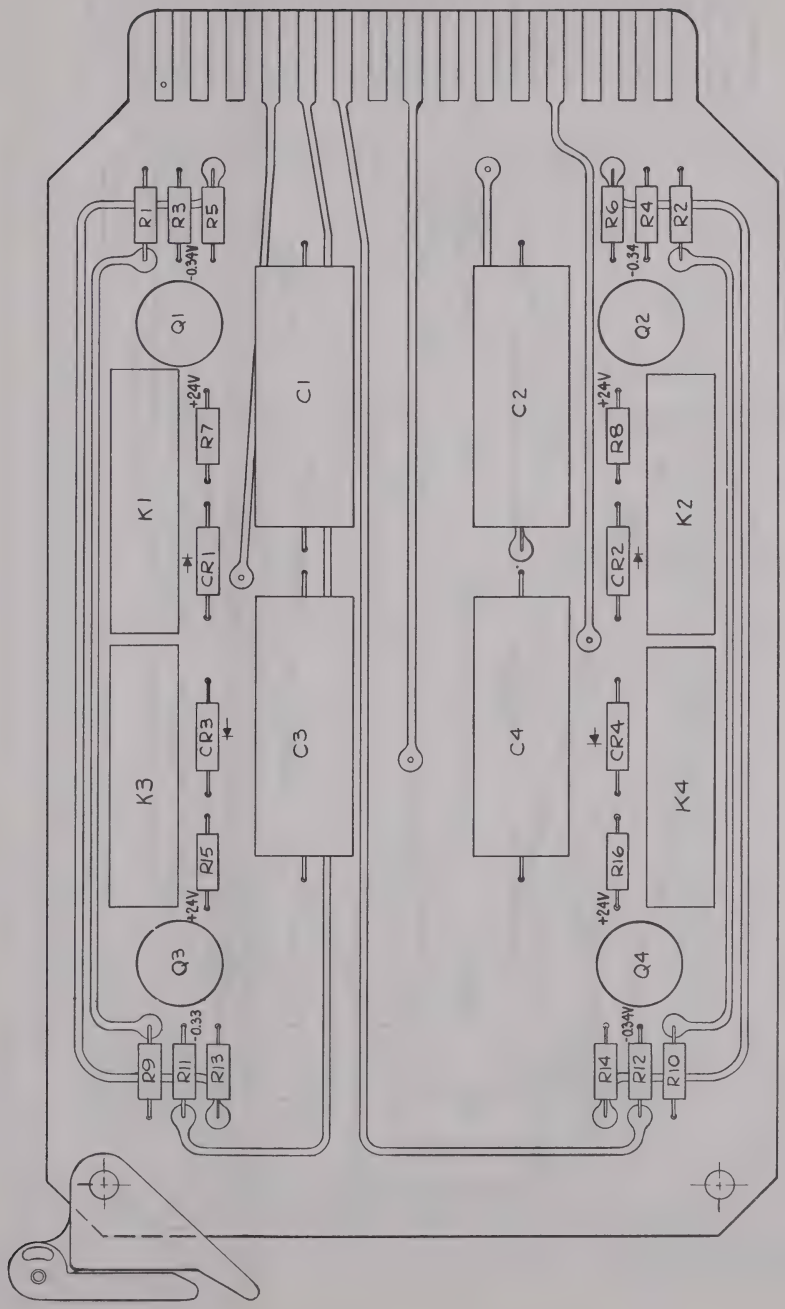


Figure 5-15. Synchronization Gates Parts Location Diagram, 1A1A2A4

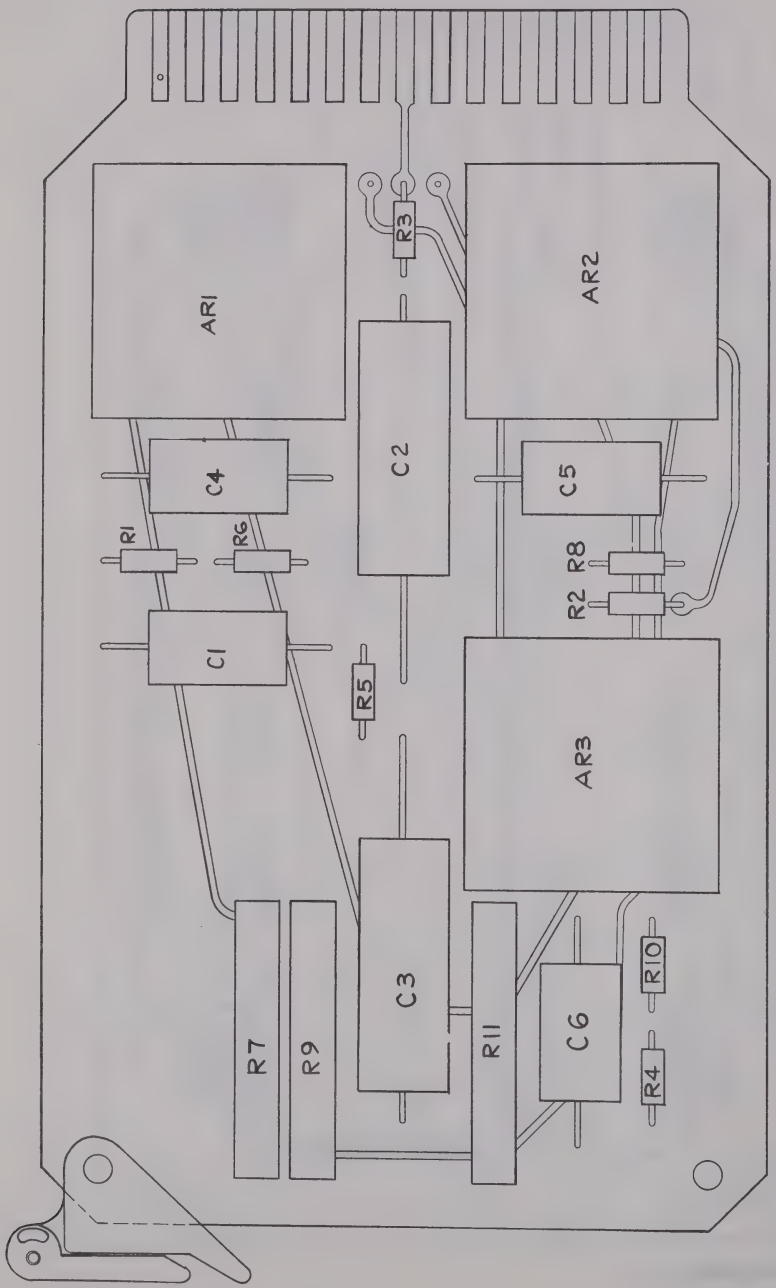


Figure 5-16. Synchronization Indicator Integrator Parts Location Diagram, 1A1A2A5

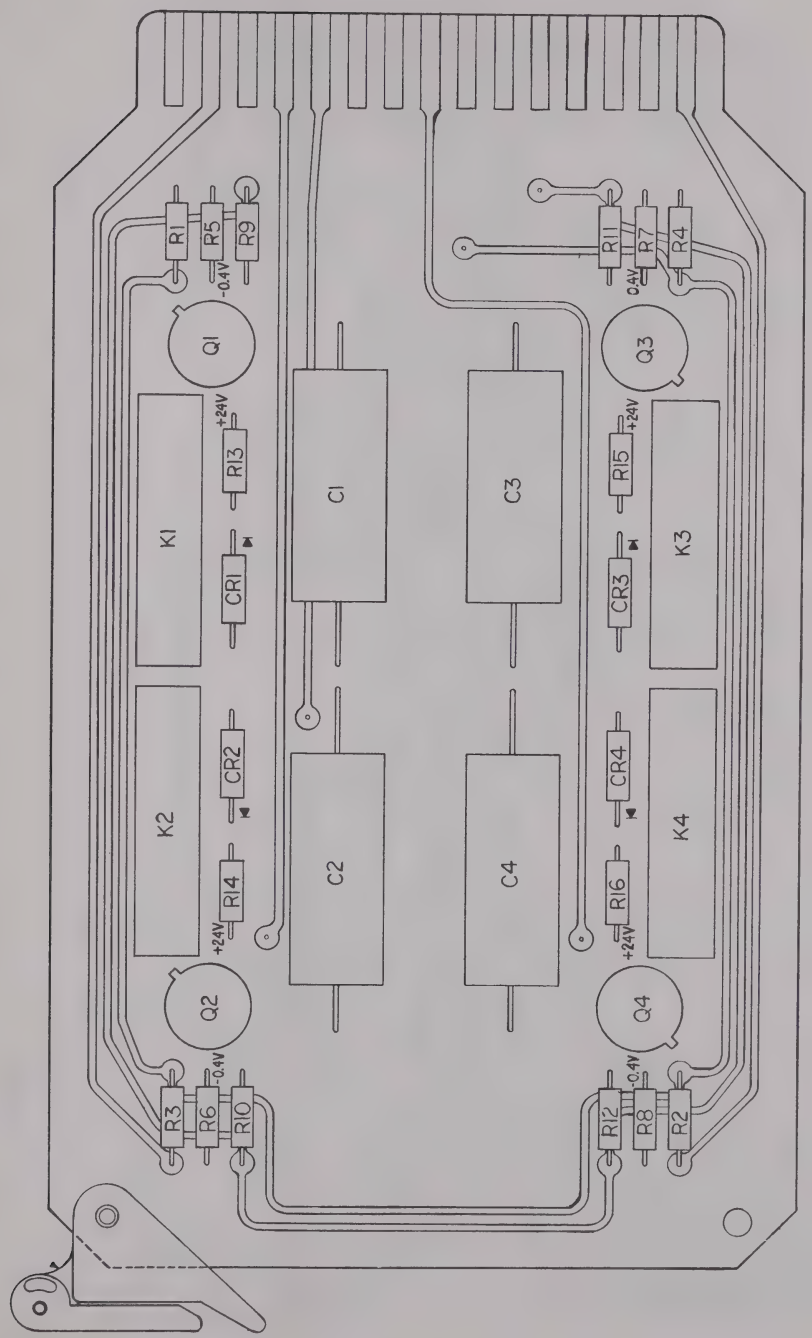


Figure 5-17. Lock Relay Drivers Parts Location Diagram, 1A1A2A6

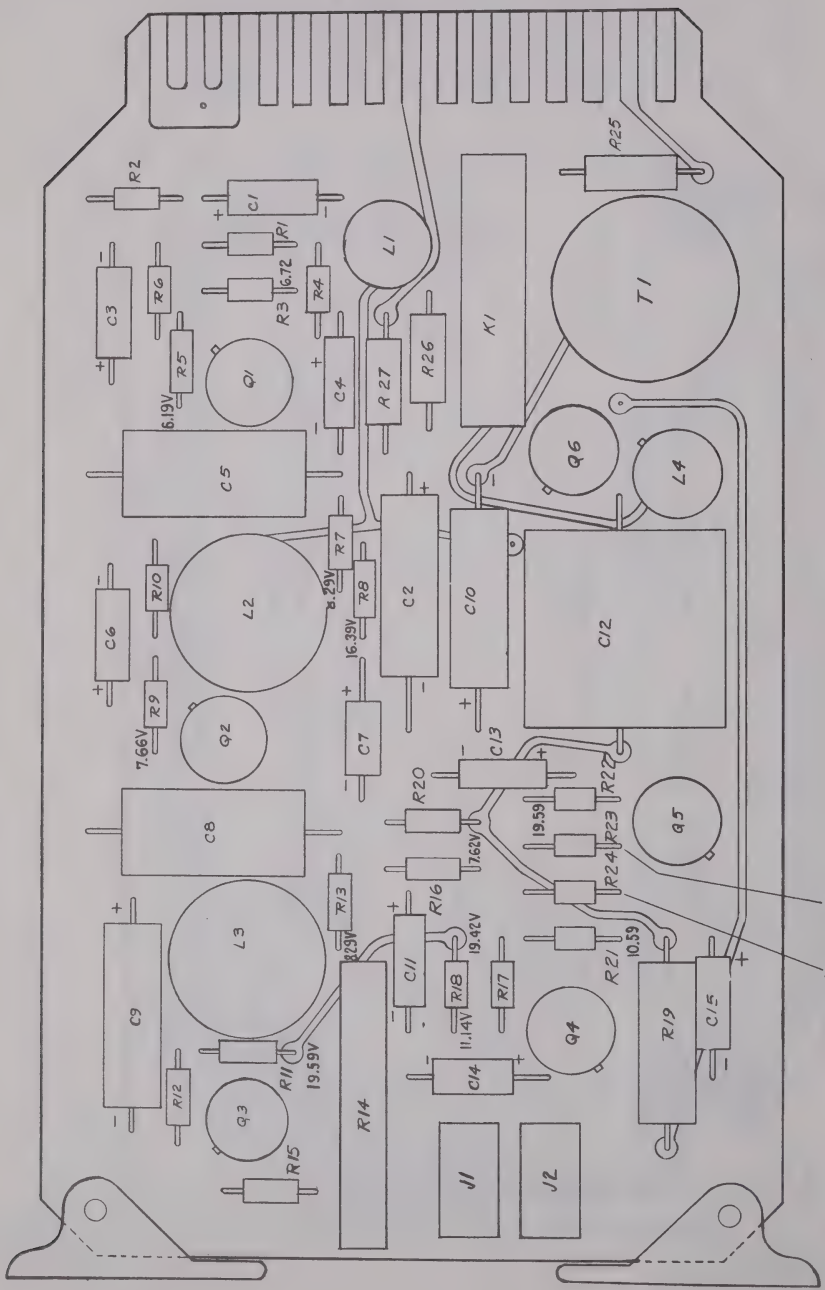


Figure 5-18. Driver and 90-Degree Phase Shifter Parts Location Diagram, 1A1A2A7

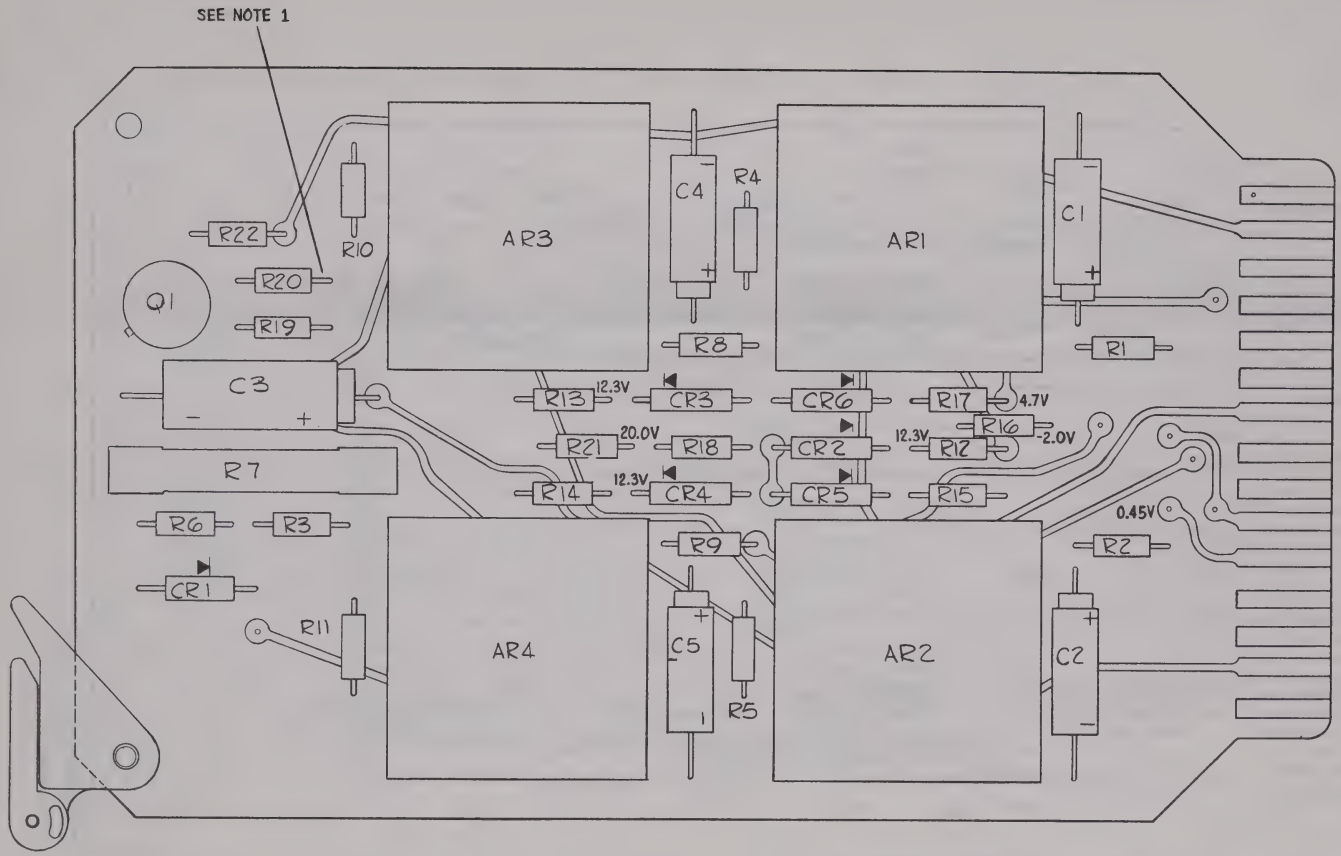


Figure 5-19. Phase Lock Indicator Amplifier Parts Location Diagram, 1A1A2A8

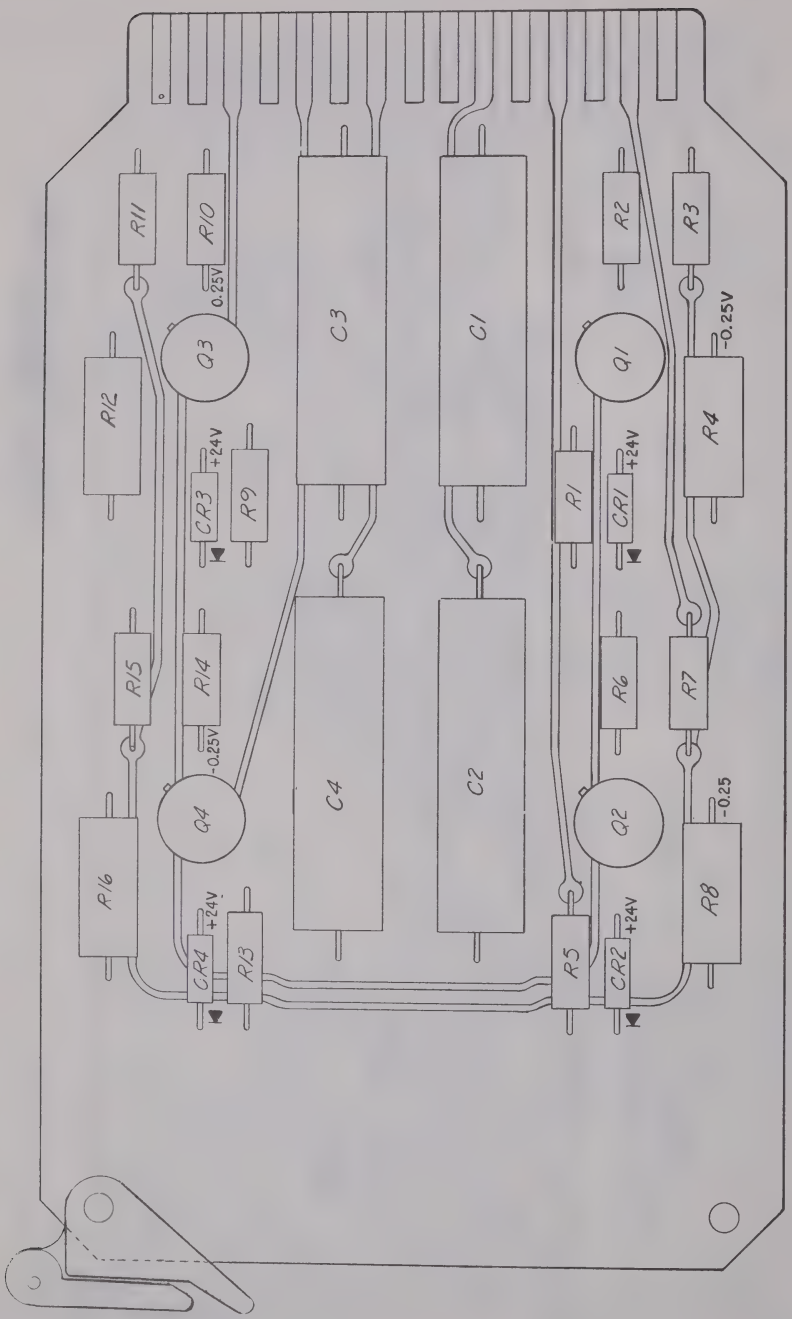


Figure 5-20. Sample Relay Drivers Parts Location Diagram, 1A1A2A9

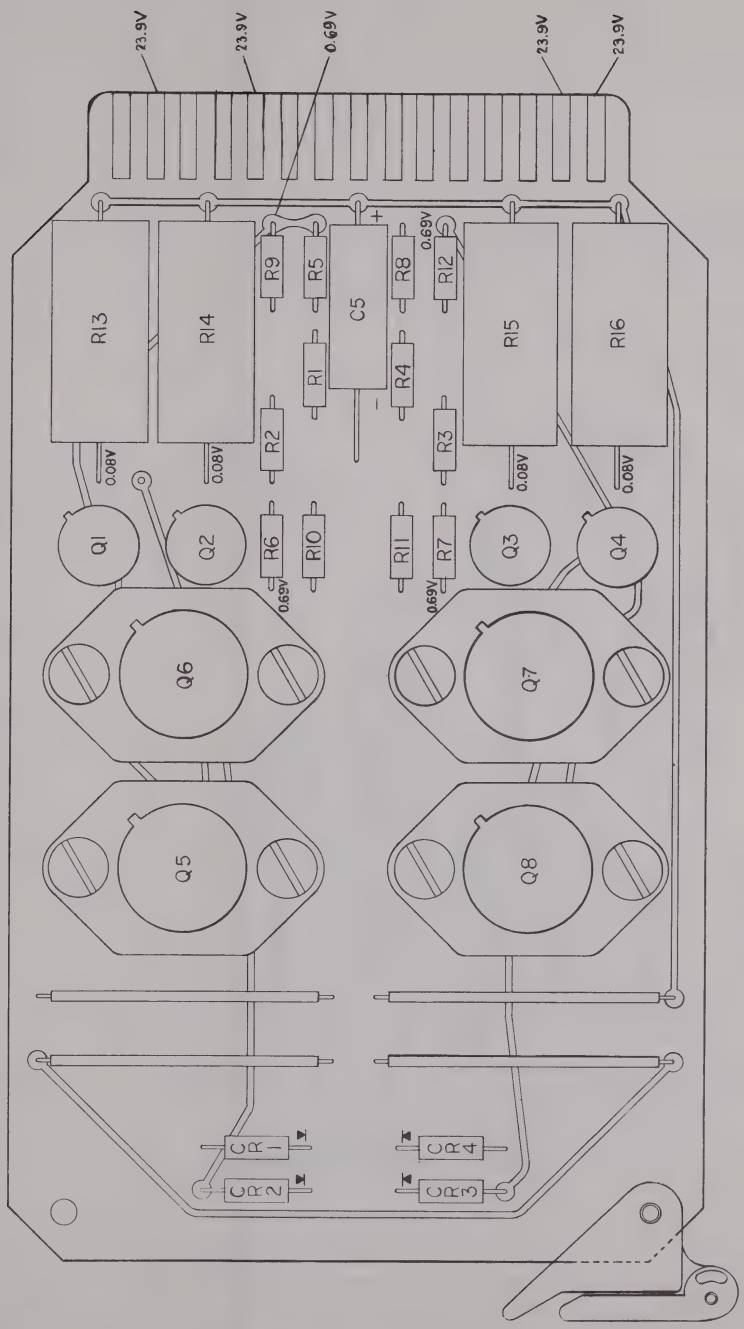
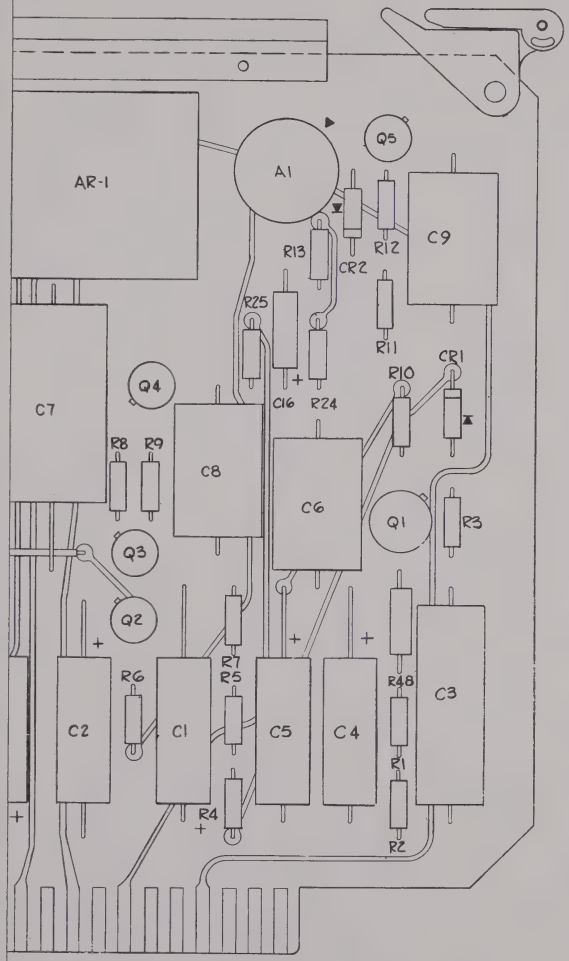


Figure 5-21. Lane Counter Drivers Parts Location Diagram, 1A1A2A12



onverter Parts Location Diagram, 1A1A3A1

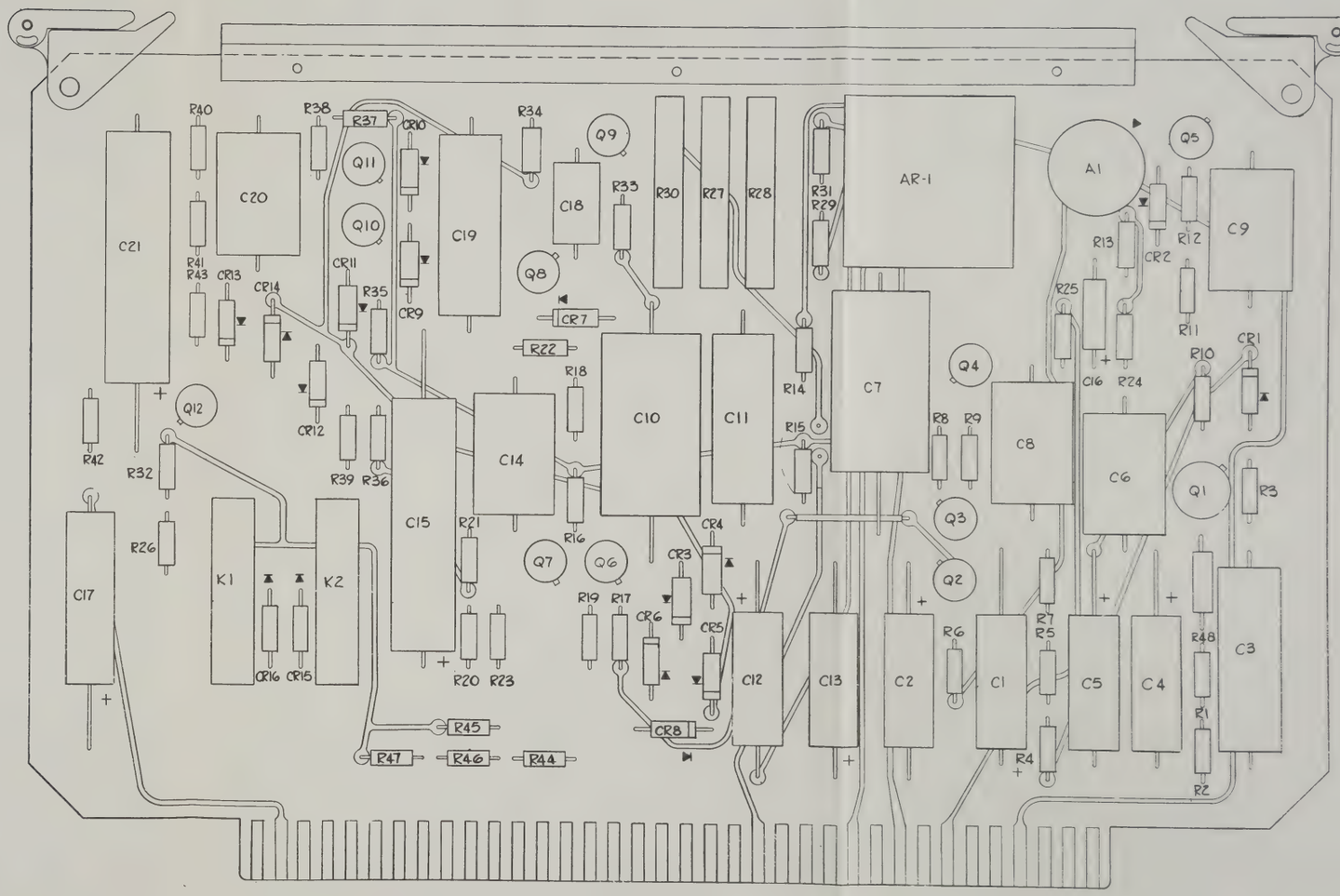
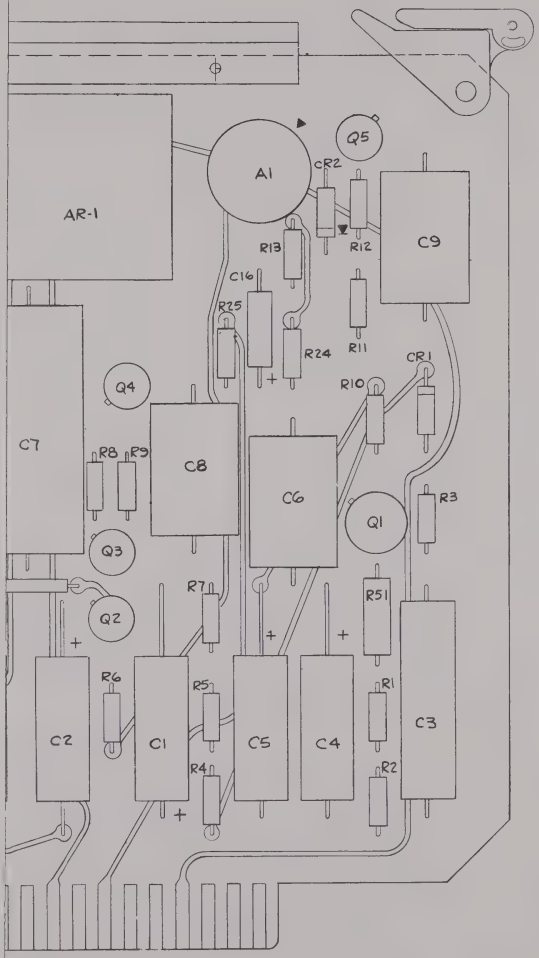


Figure 5-22. Phase Converter Parts Location Diagram, 1A1A3A1



and Times-Three Circuit Parts Location
ram, 1A1A3A2

96
95

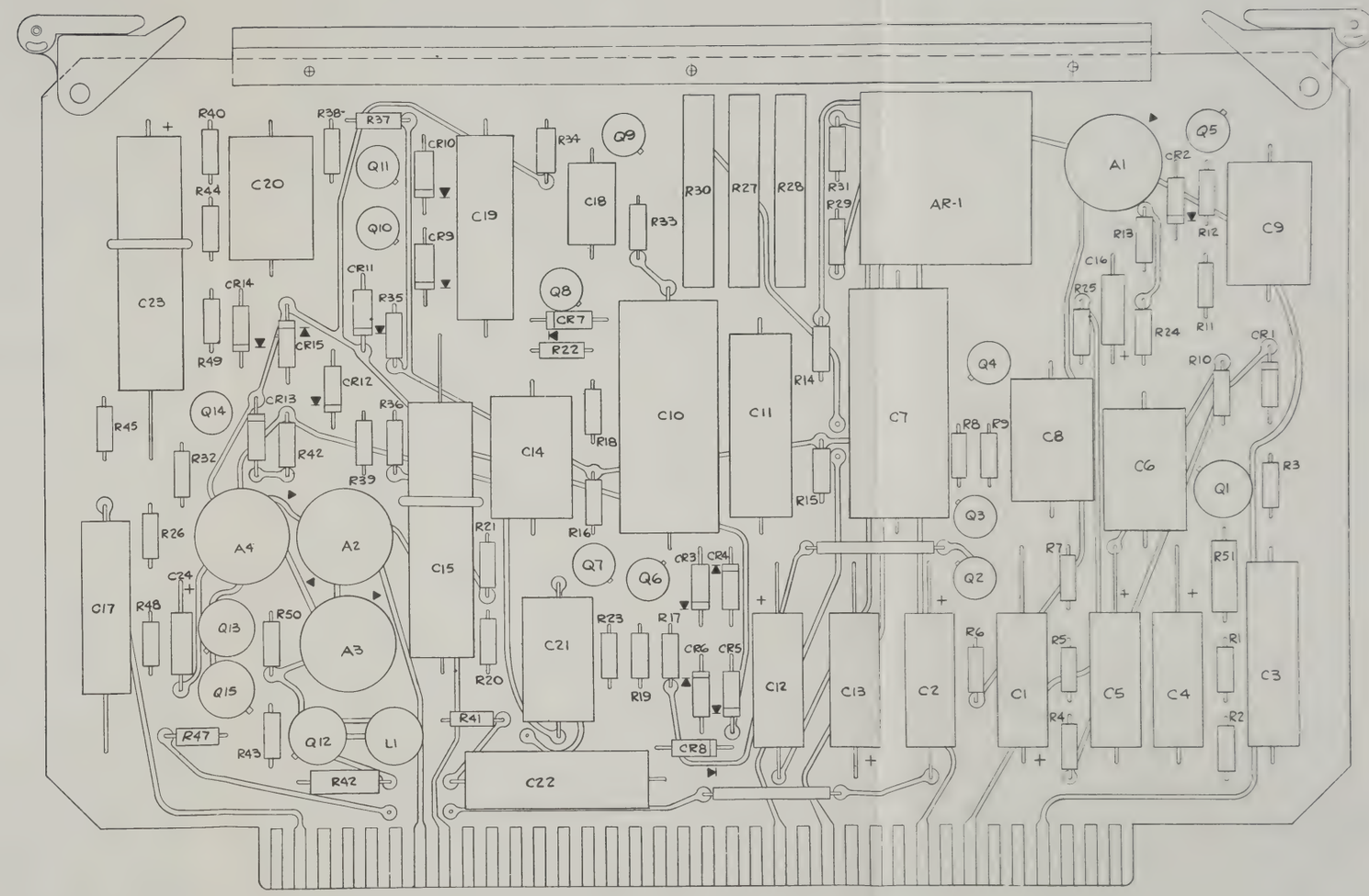


Figure 5-23. Phase Converter and Times-Three Circuit Parts Location Diagram, 1A1A3A2

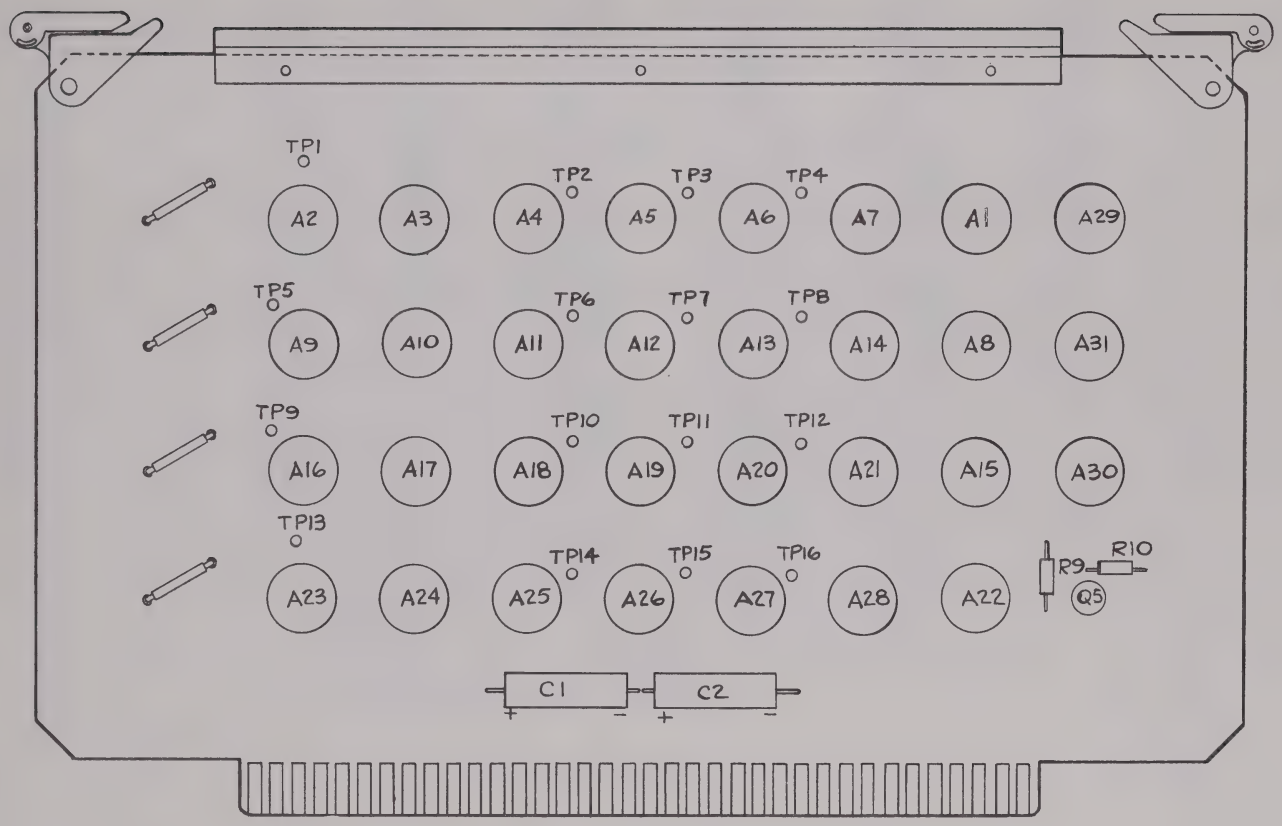


Figure 5-24. Tracker Counter and Switching Matrix Parts Location Diagram, 1A1A3A3

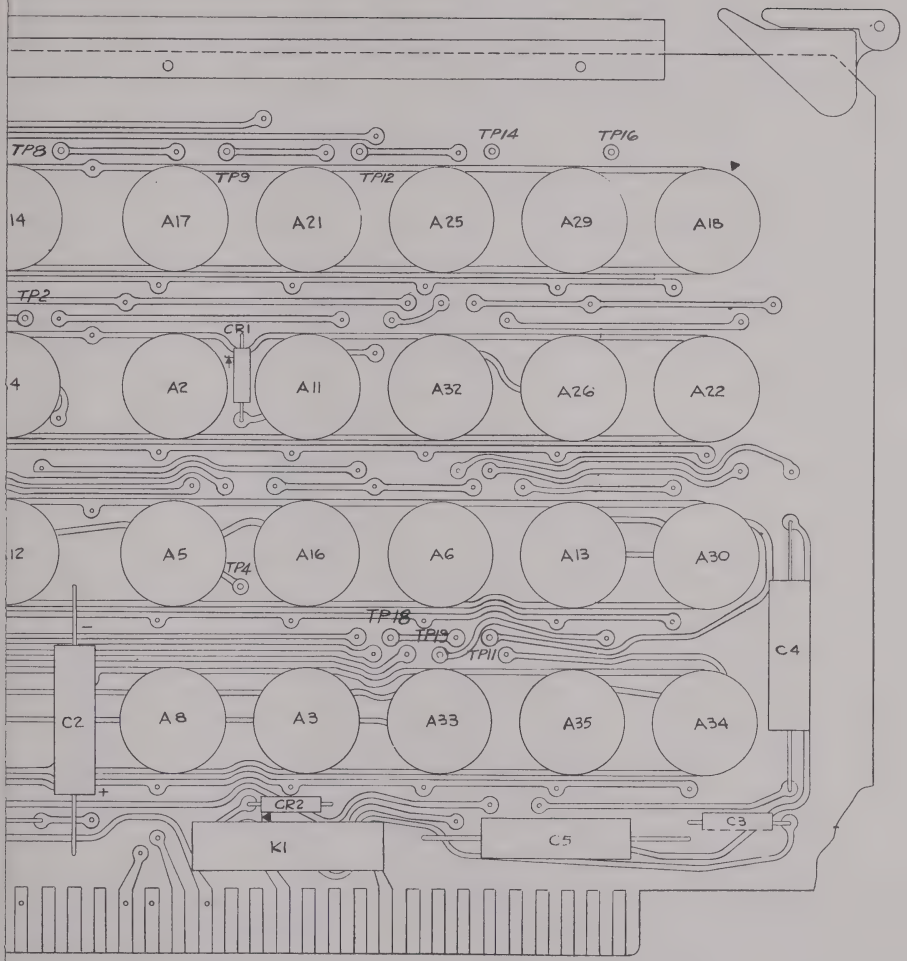


Figure 5-25. Divide by 850 Timing Signal Generator and Adder Delete Parts Location Diagram, 1A1A3A4

99 100

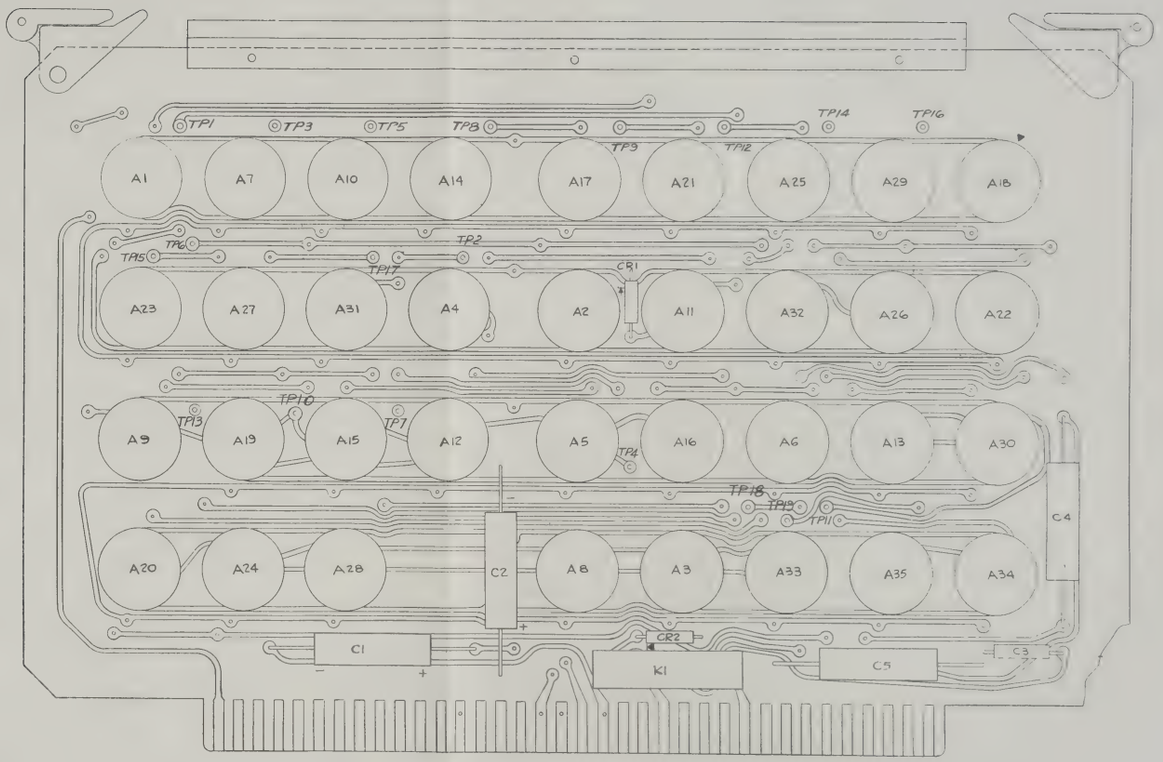


Figure 5-25. Divide by 850 Timing Signal Generator and Adder Delete Parts Location Diagram, 1A1A3A4

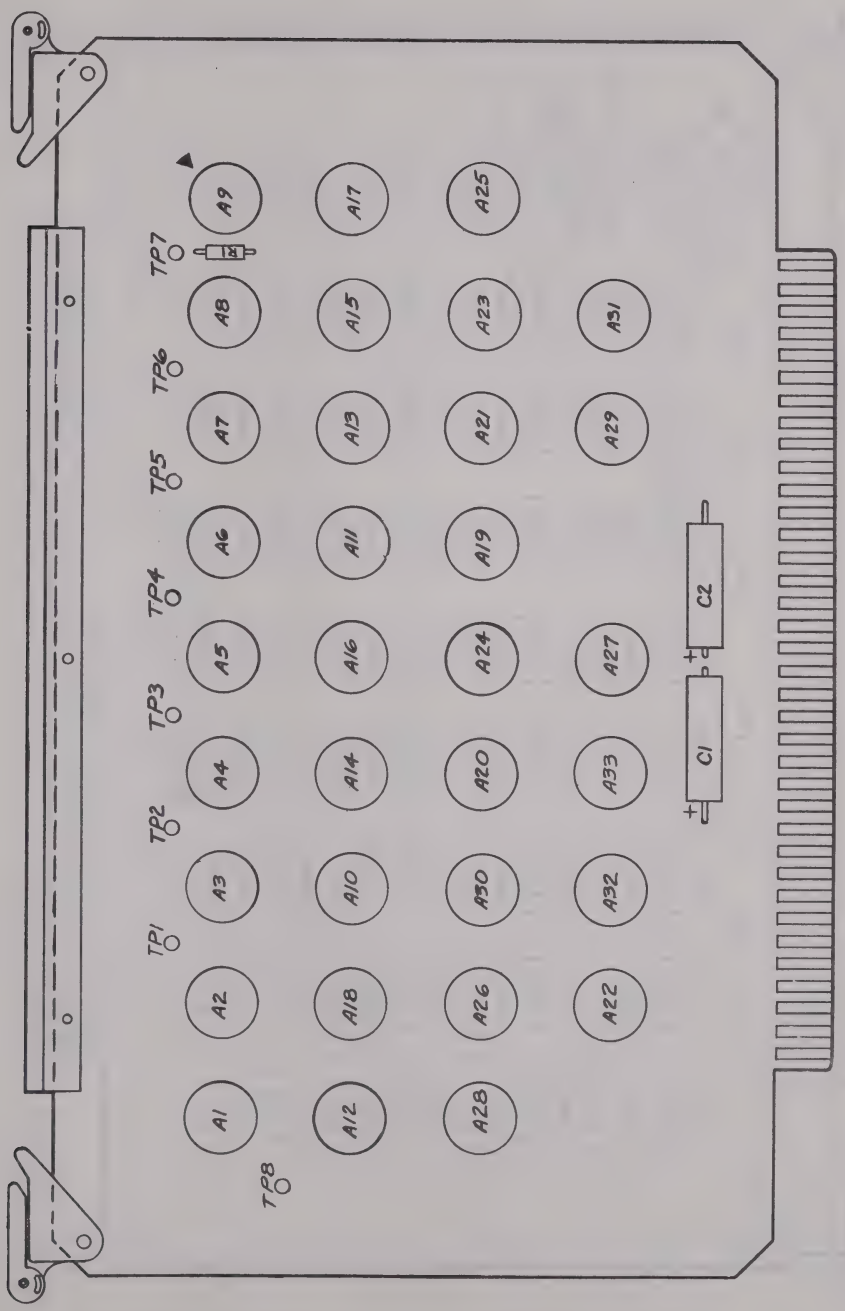


Figure 5-26. Timer, Primary Counter, and Matrix Parts Location Diagram, 1A1A3A5

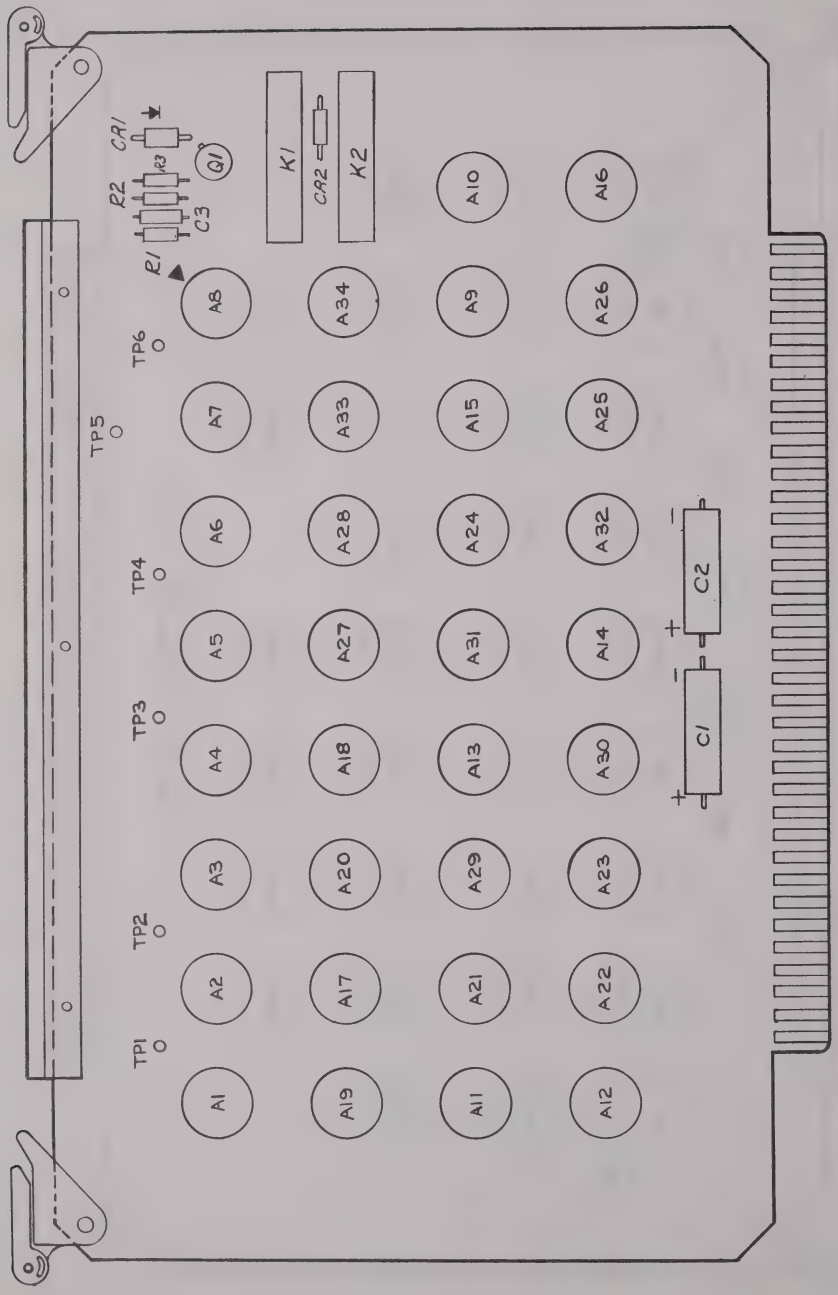


Figure 5-27. Synchronization Indicator, Or Gates, and Divide by 8, Divide by 10 Parts Location Diagram, 1A1A3A6

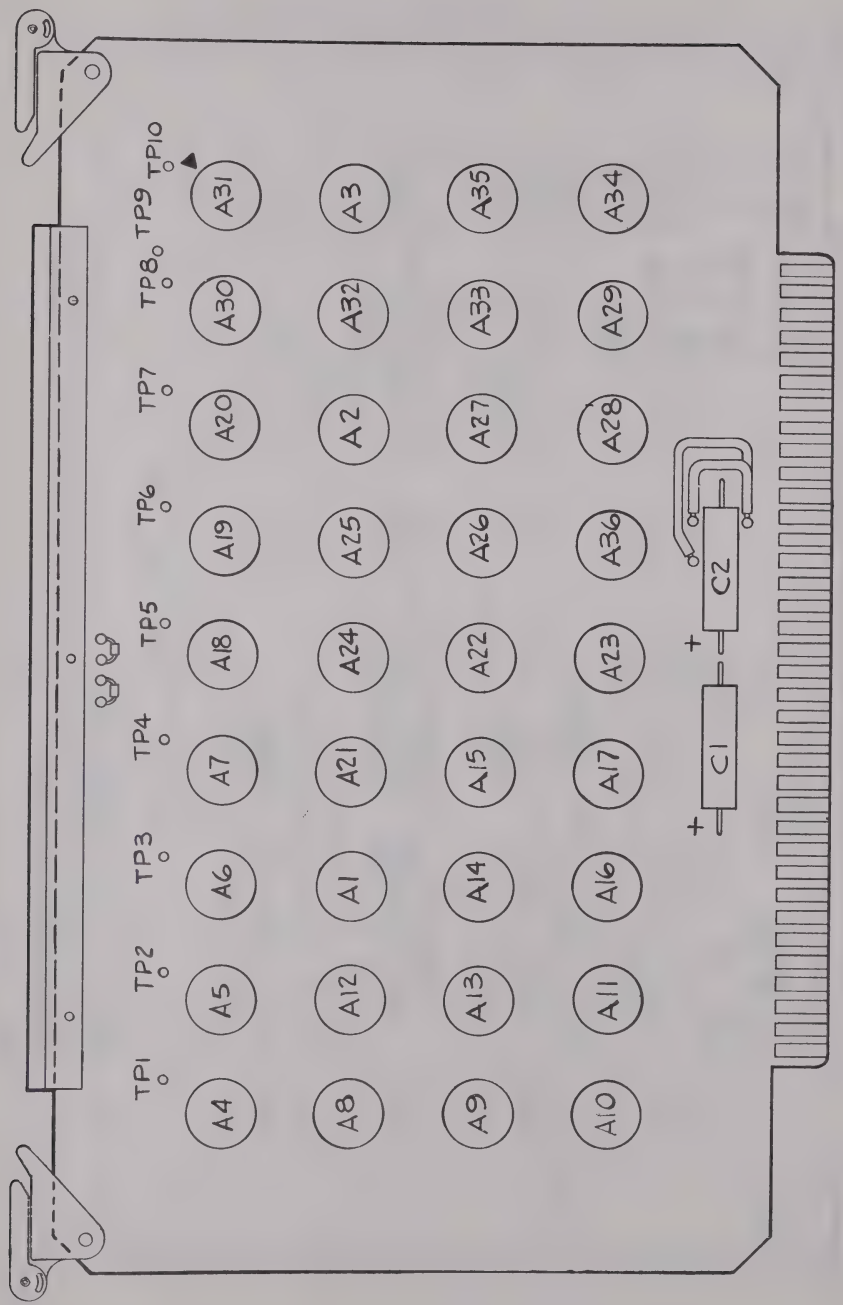


Figure 5-28. Secondary Number Decoding Gates Parts Location Diagram, 1A1A3A7

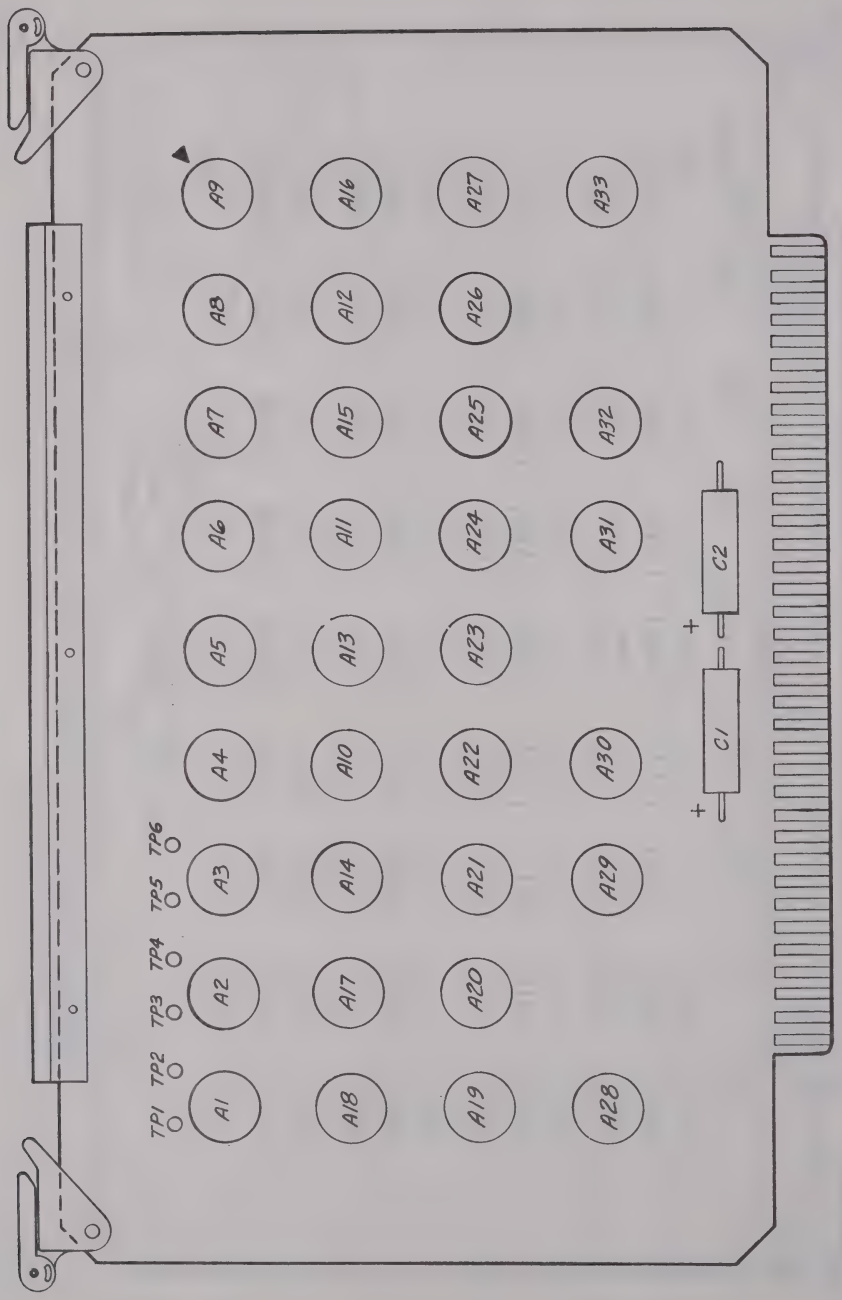


Figure 5-29. Station Gate Flip-Flops and Second Counter Parts Location Diagram, 1A1A3A8

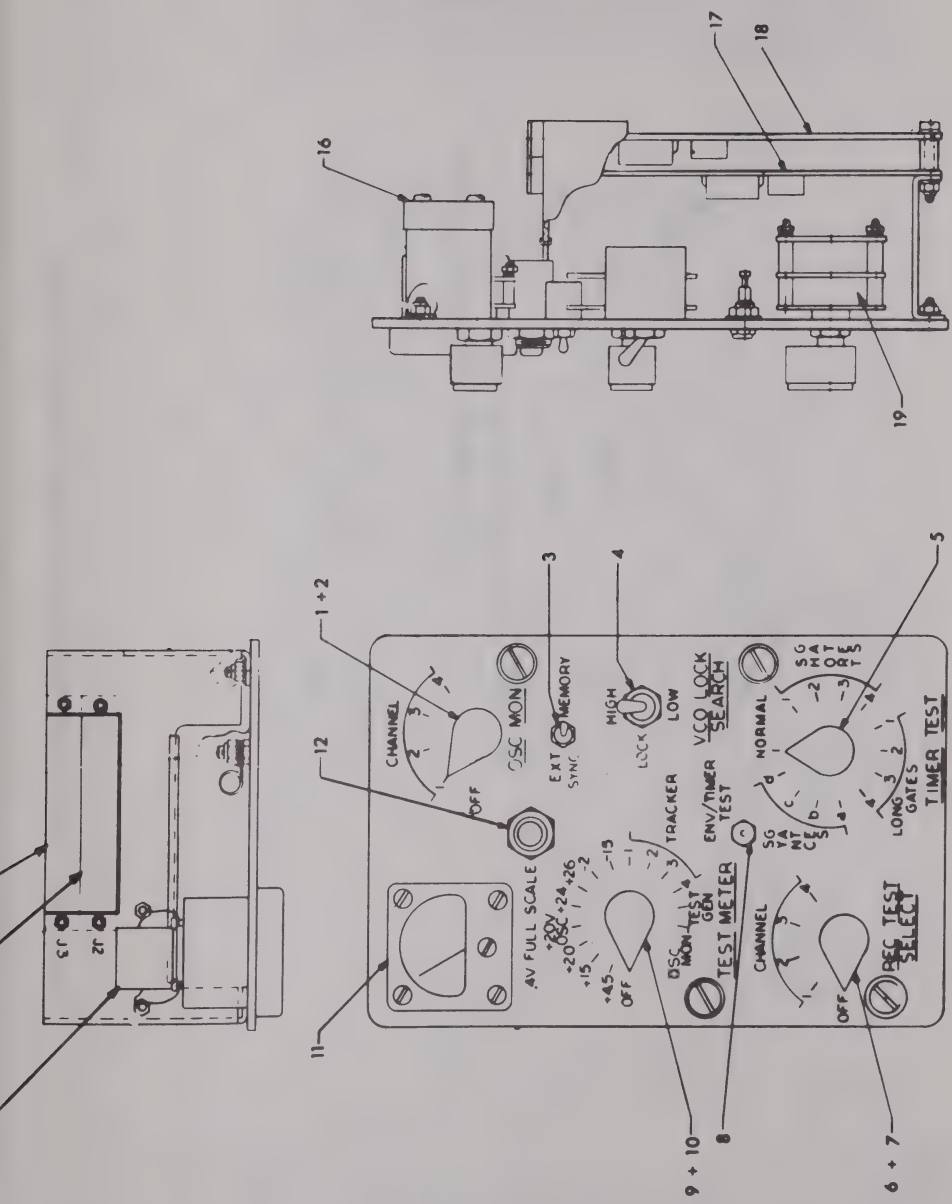


Figure 5-30. Test Panel Assembly Diagram

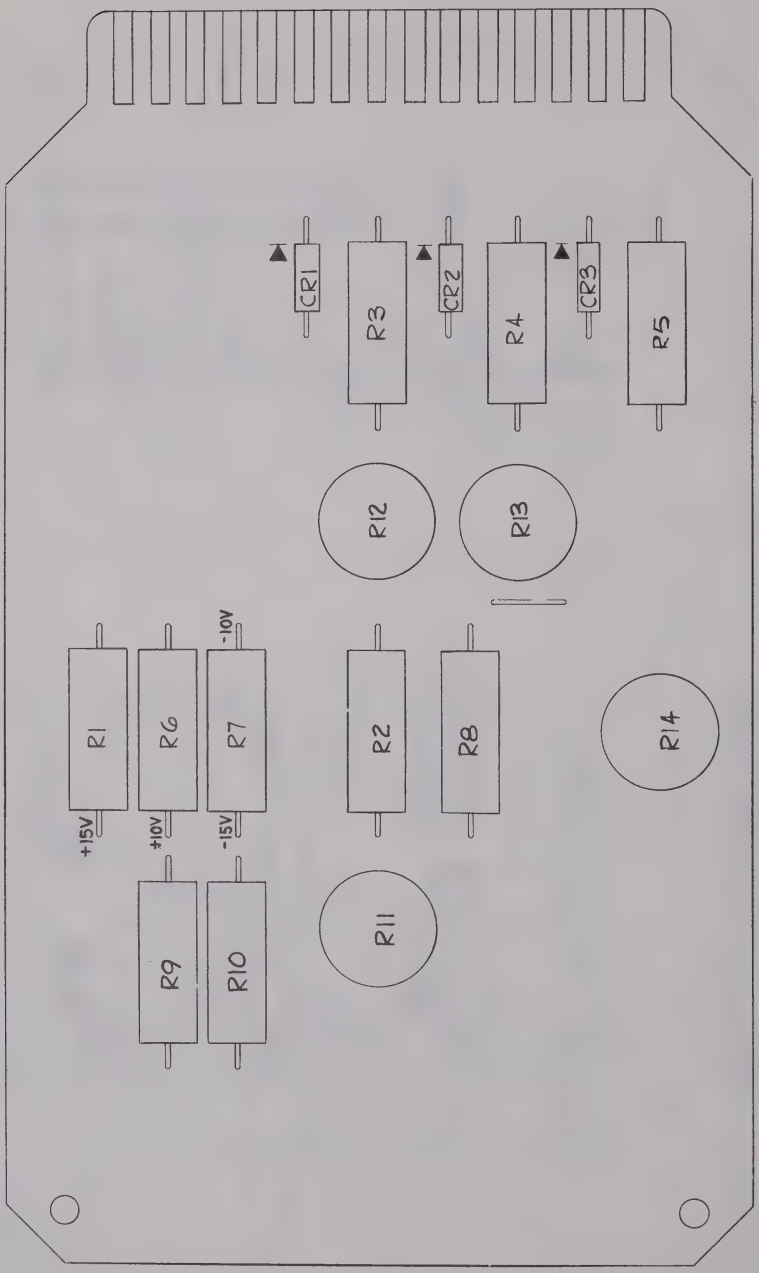


Figure 5-31. First Voltage Divider Parts Location Diagram, 1A1A4A1

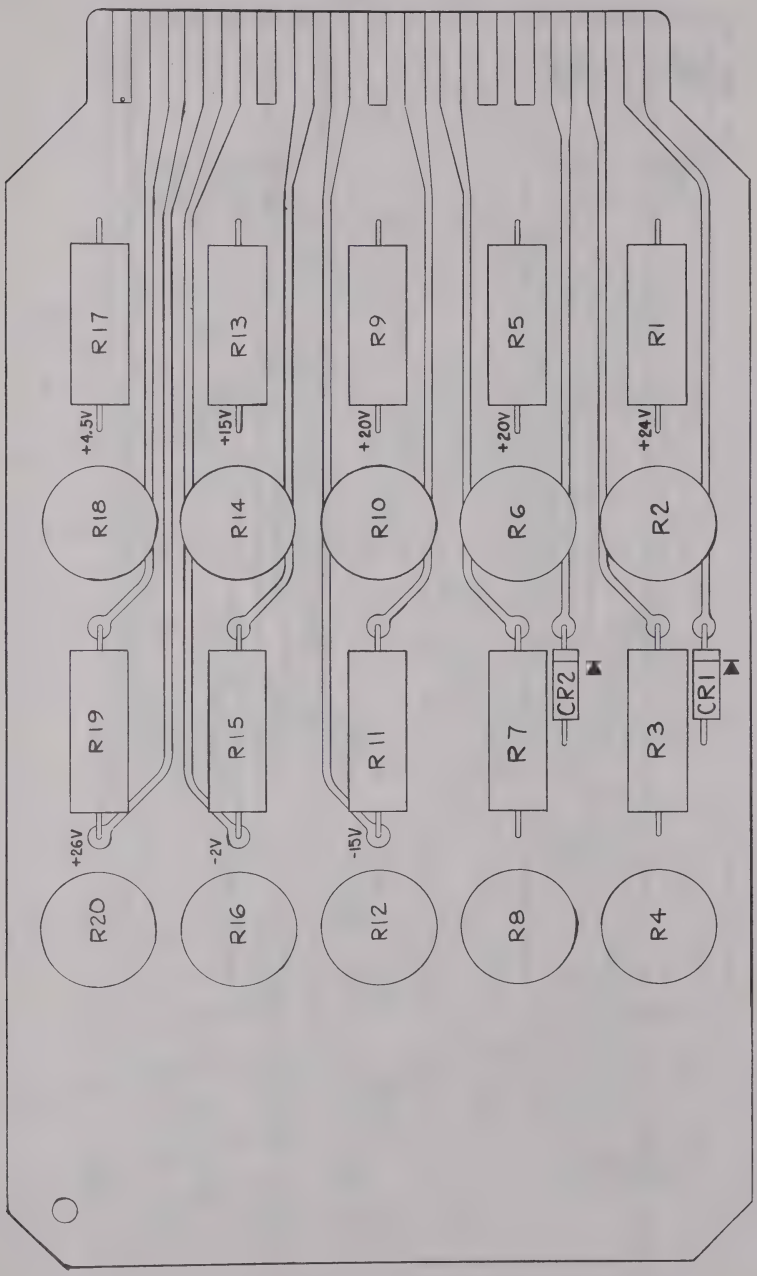


Figure 5-32. Second Voltage Divider Parts Location Diagram, 1A1A4A2

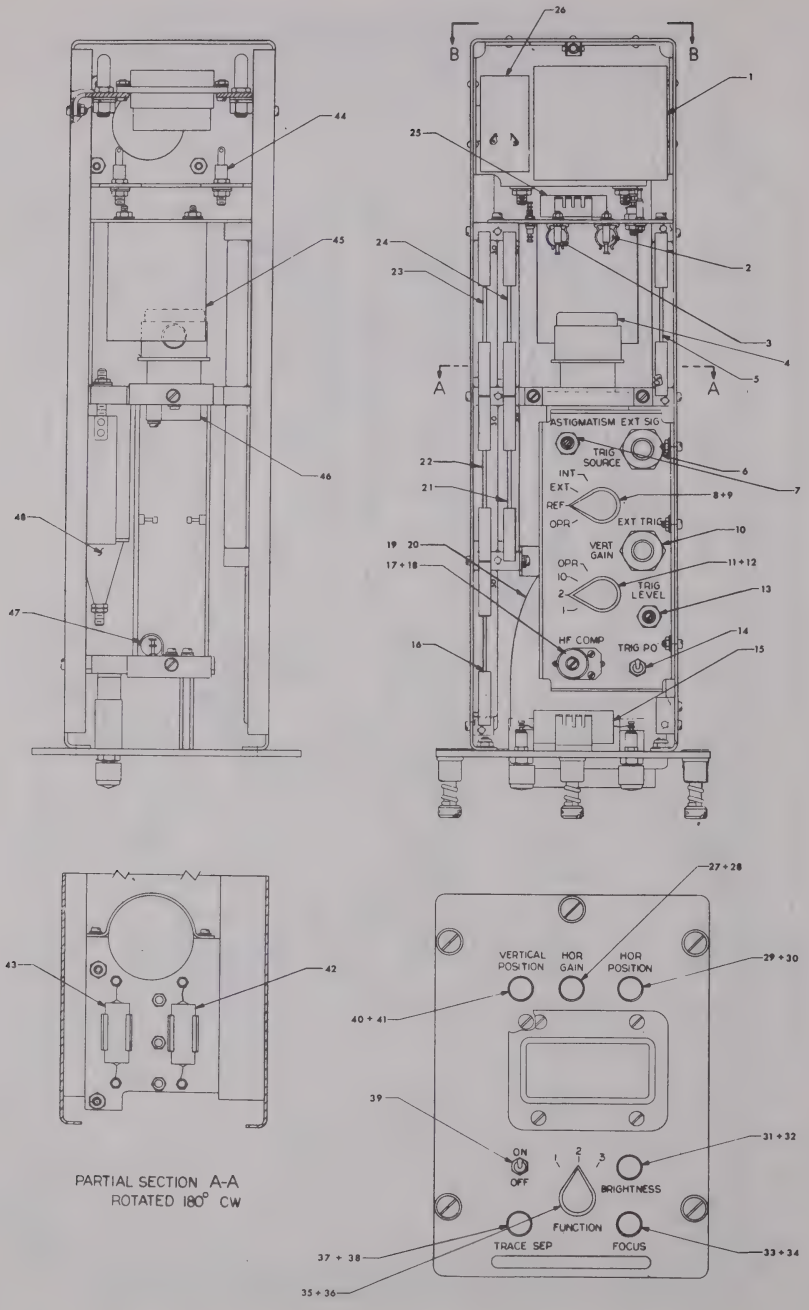


Figure 5-33. Test Oscilloscope Assembly Diagram

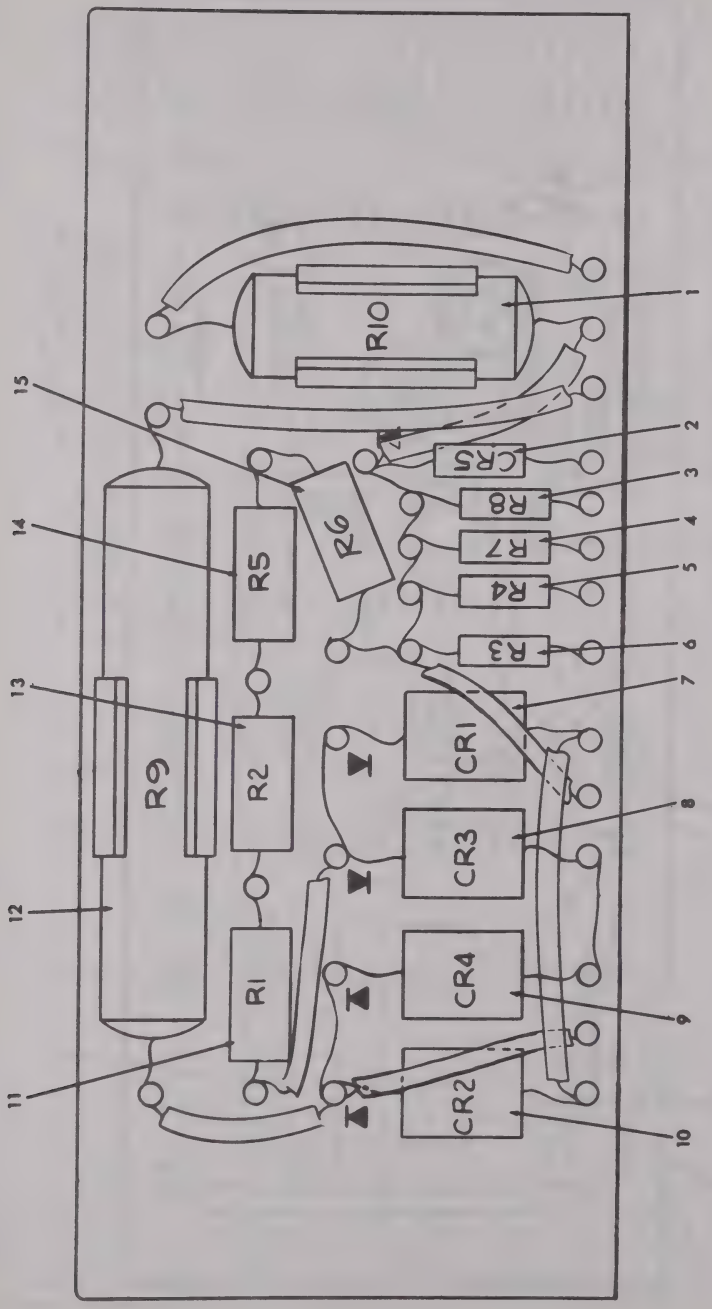


Figure 5-34. 1000 VDC Rectifier Assembly Diagram

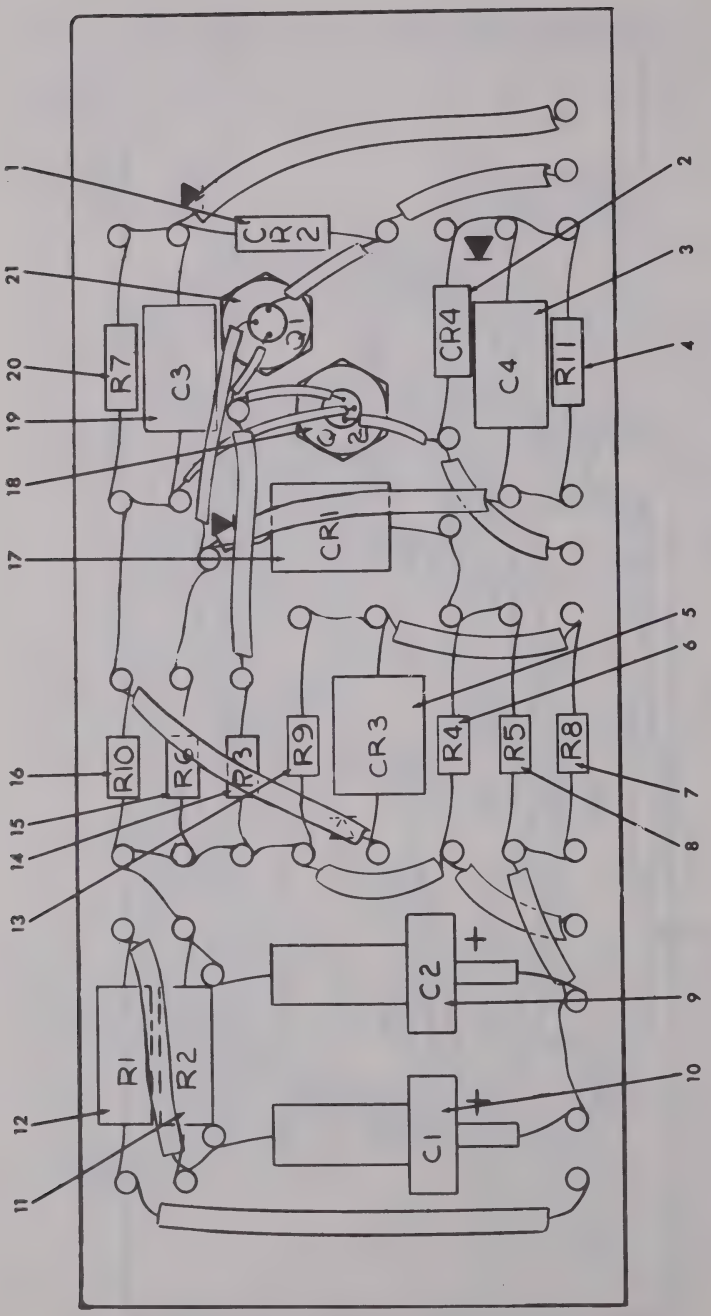


Figure 5-35. 35 VDC Rectifier and Horizontal Blanking Assembly Diagram

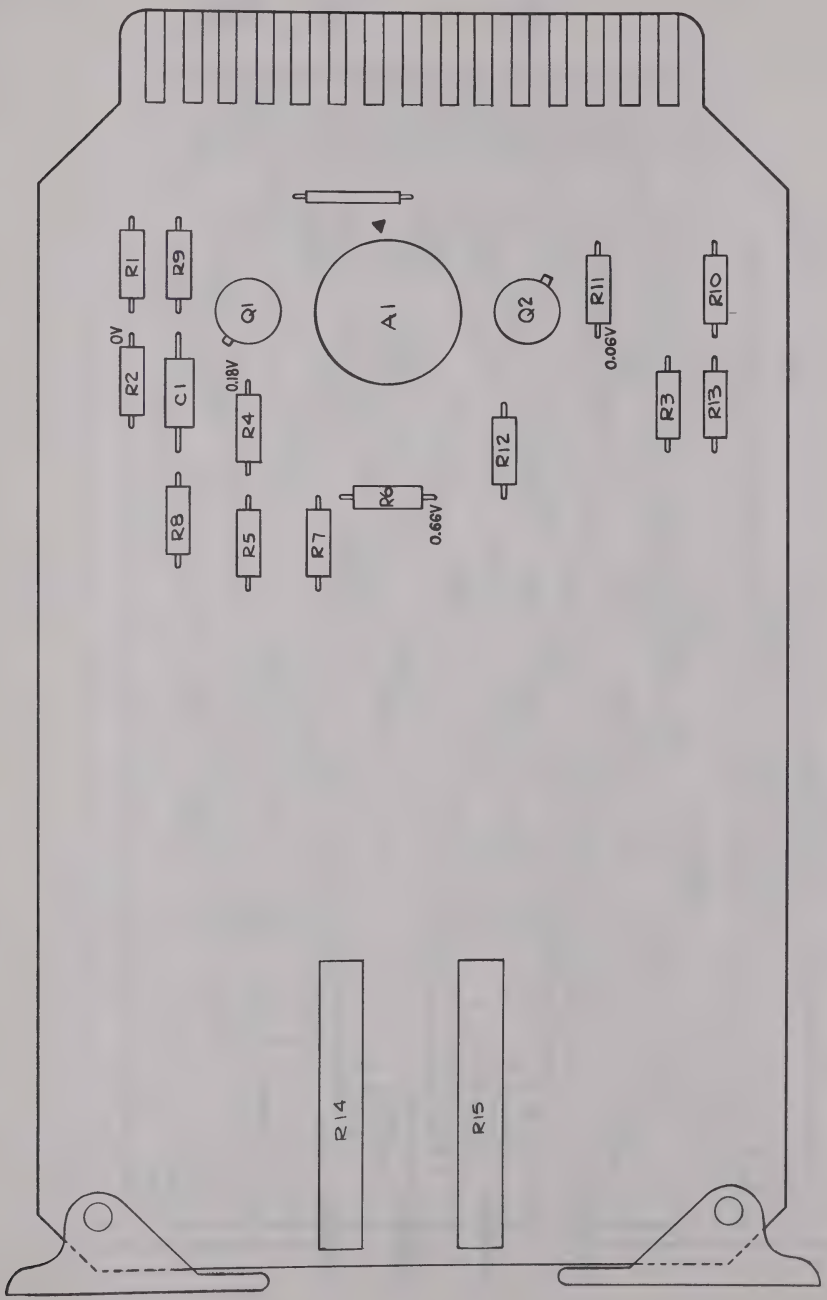


Figure 5-36. Electronic Switch Parts Location Diagram, 1A1A7A1

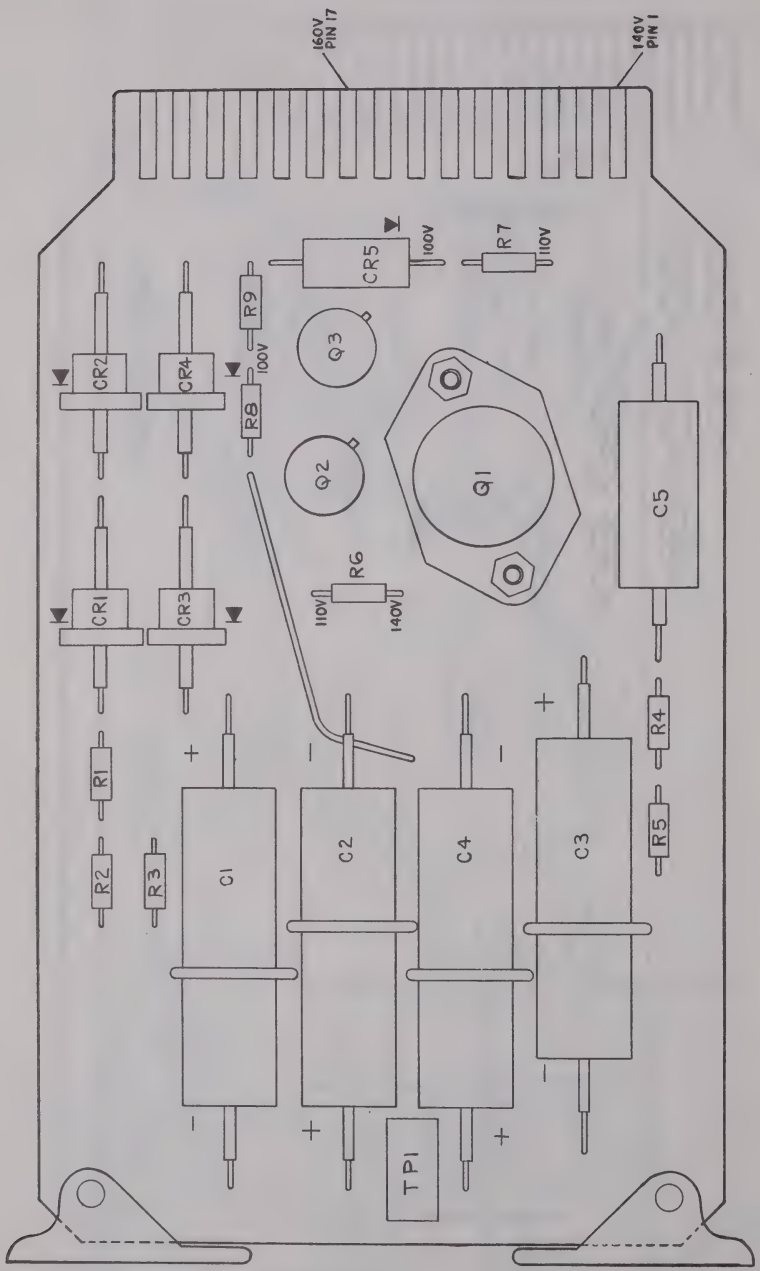


Figure 5-37. Regulated +110 VDC Rectifier Parts Location Diagram, 1A1A7A2

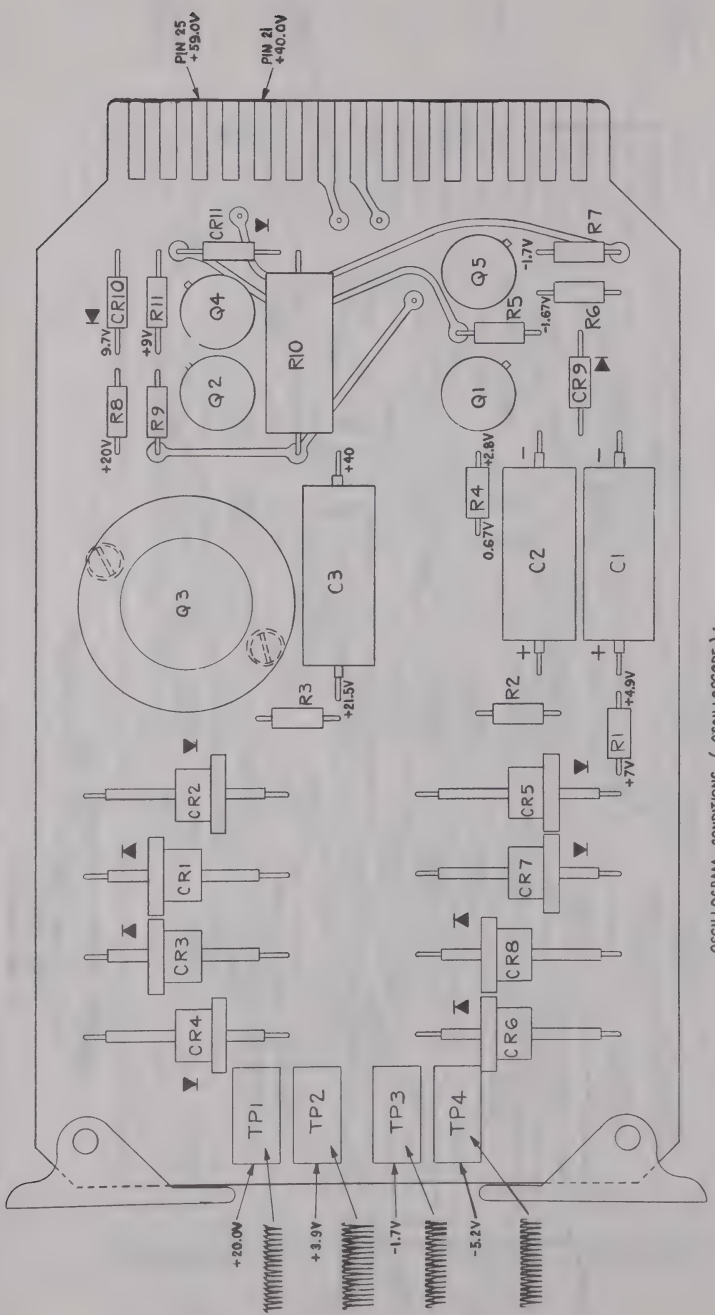
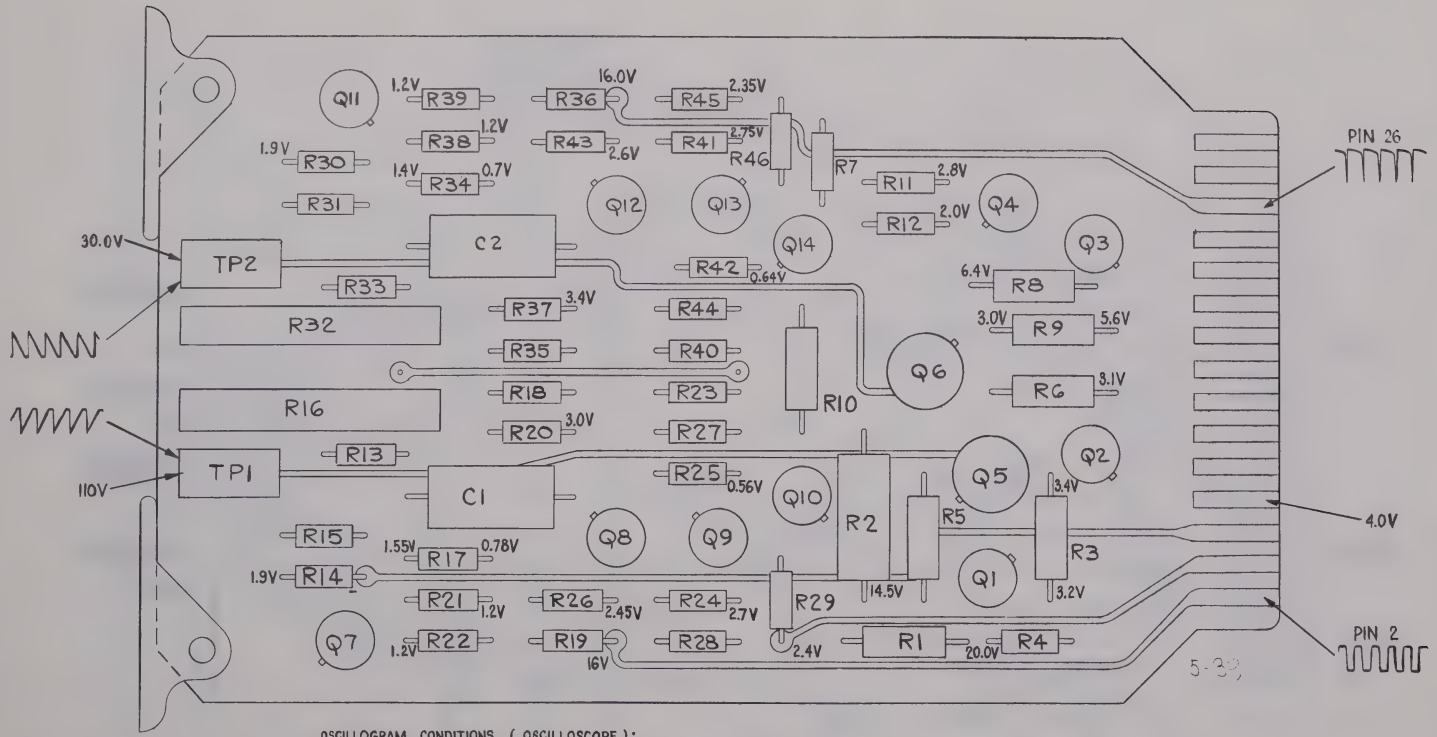


Figure 5-38. Regulated +20 VDC Rectifier Parts Location Diagram, 1A1A7A3



OSCILLOGRAM CONDITIONS (OSCILLOSCOPE):

1. 0.5 V P-P 16KC SINE WAVE (EXT SIG JACK) INPUT.
2. FUNCTION SWITCH - 2.
3. VERT GAIN ÷ 1.
4. TRIG SOURCE - INT.
5. TRIG POLARITY - +

Figure 5-39. Horizontal Gating and Deflection Parts Location Diagram, 1A1A7A4

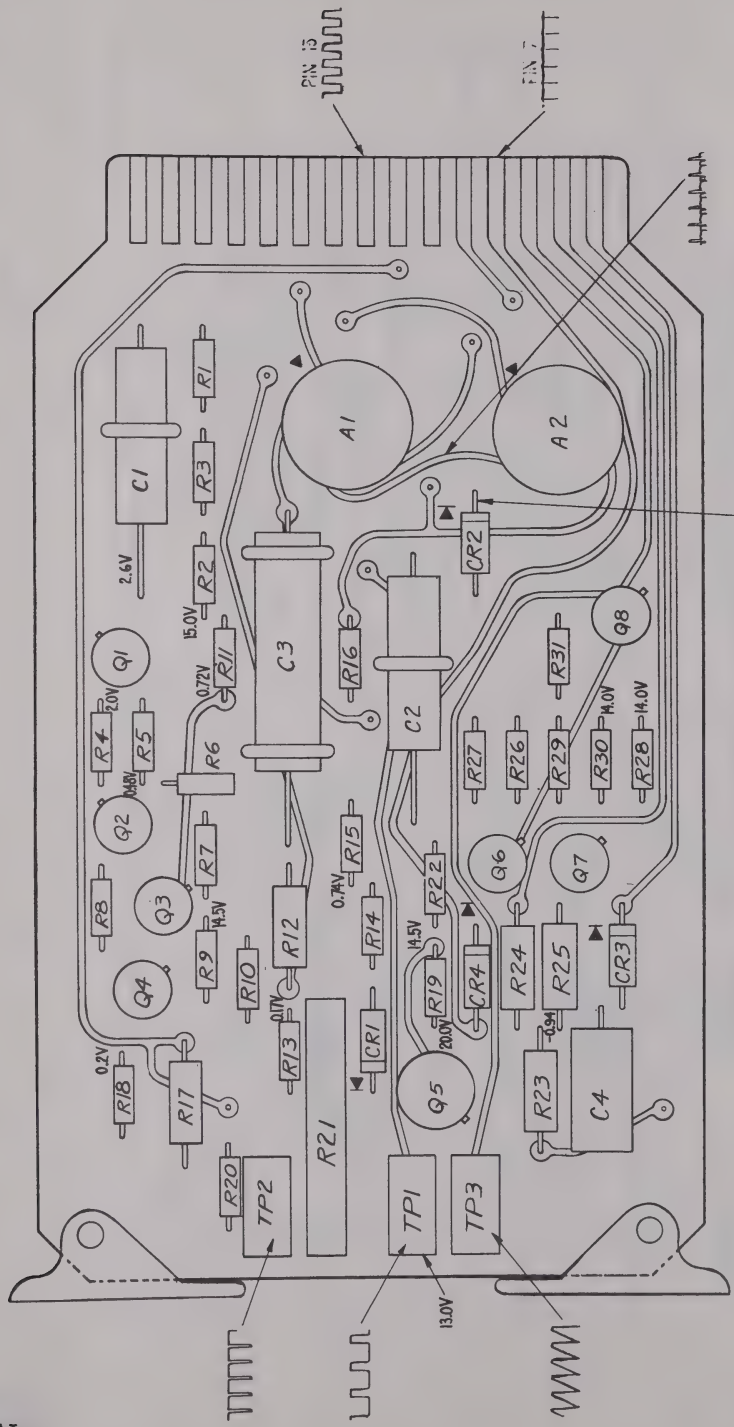


Figure 5-40. Horizontal Sweep Generator Parts Location Diagram, 1A1A7A5

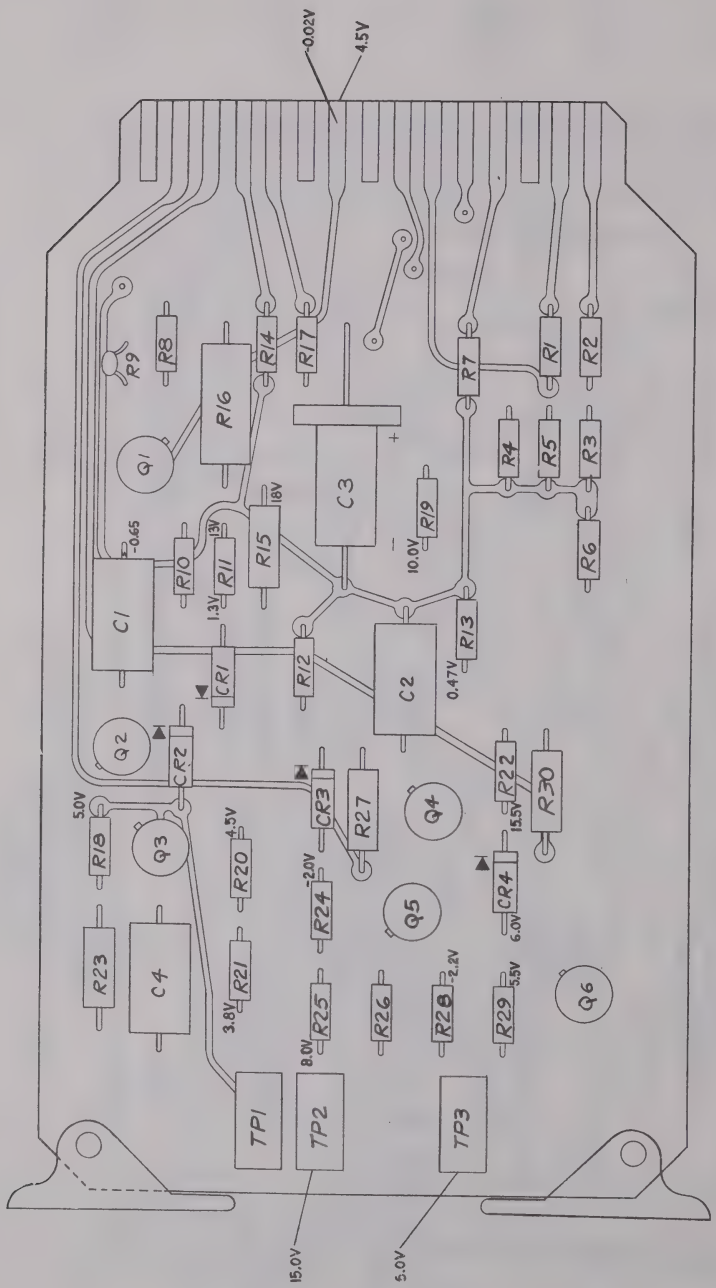


Figure 5-41. Vertical Amplifier Parts Location Diagram, 1A1A7A6

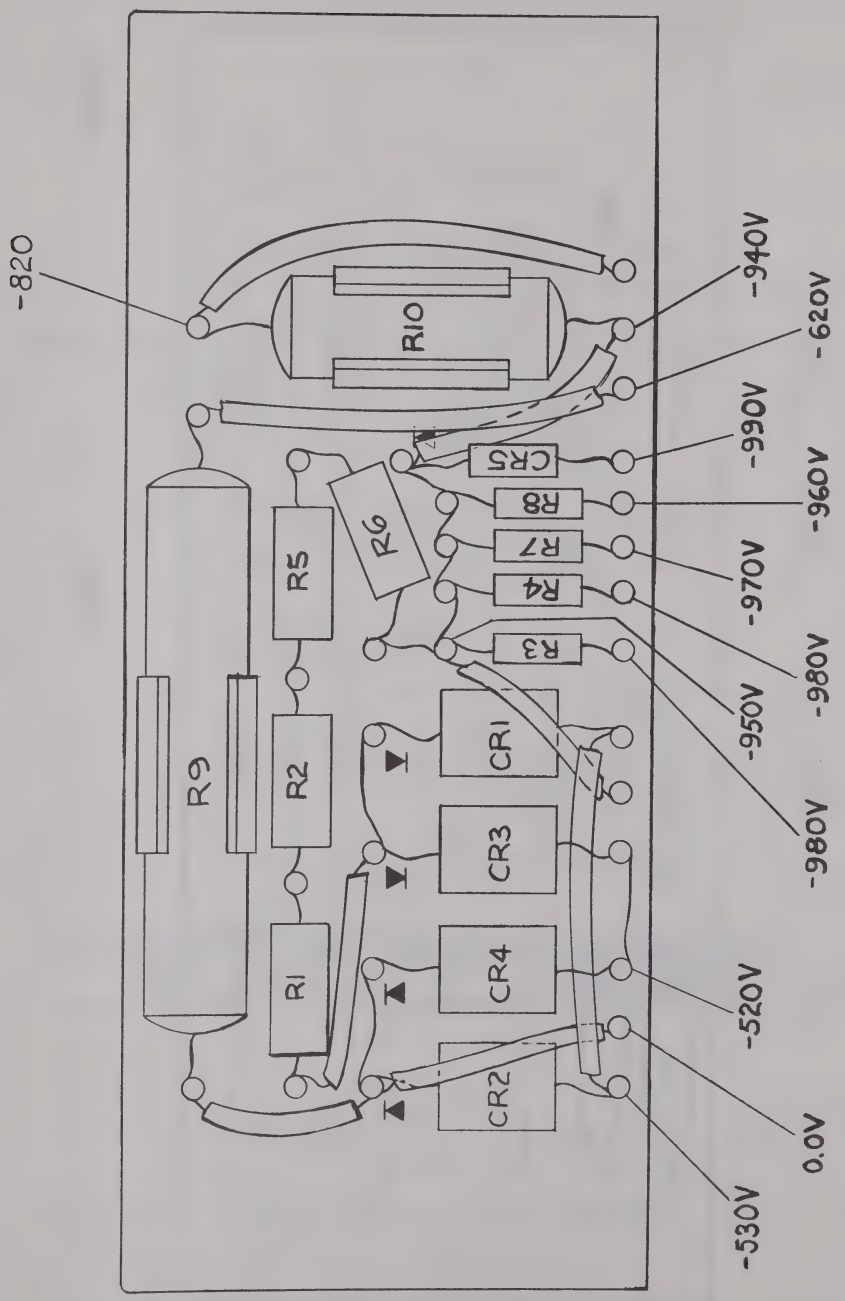


Figure 5-42. Nonregulated 1000 VDC Rectifier Parts Location Diagram, 1A1A7A7

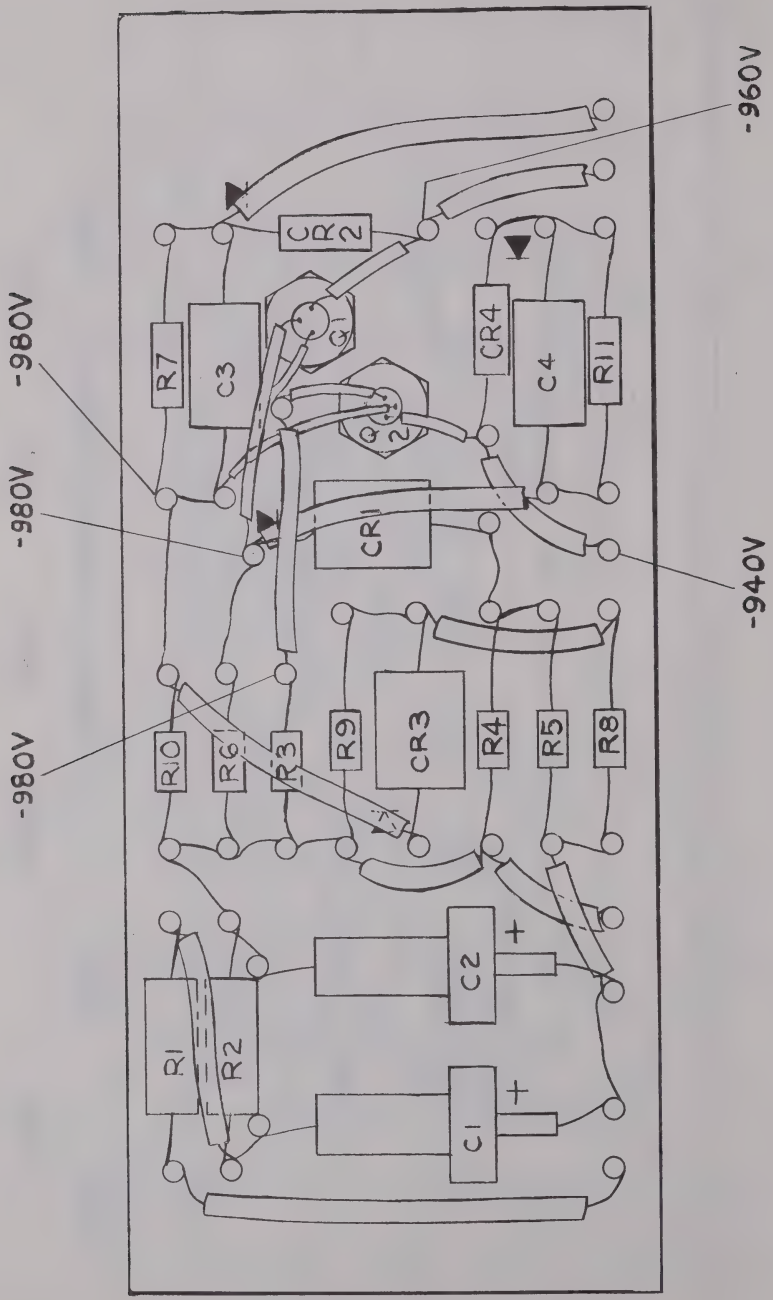


Figure 5-43. Nonregulated 35 VDC Rectifier Parts Location Diagram, 1A1A7A8

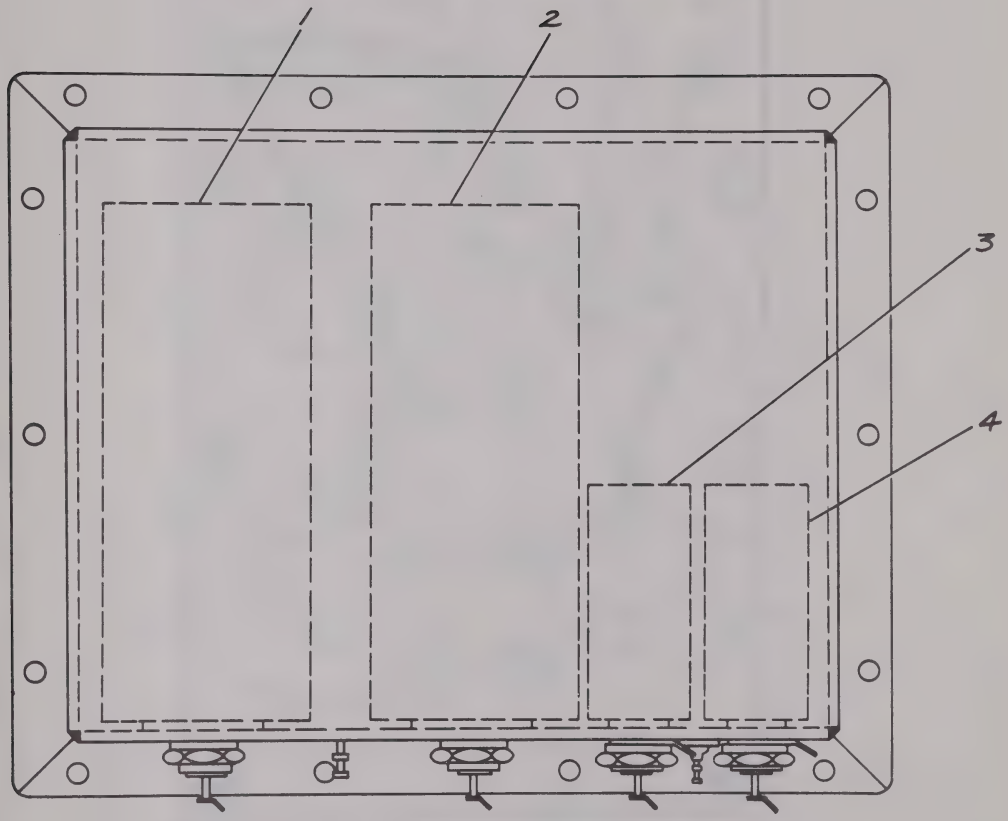


Figure 5-44. RF Interference Filters Assembly Diagram

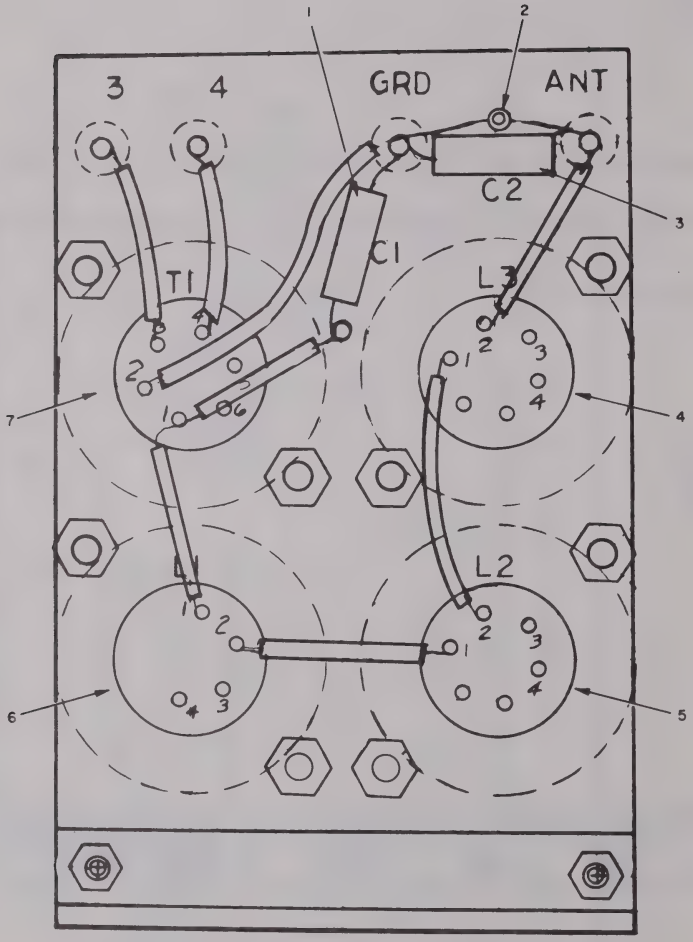


Figure 5-45. Antenna Assembly Component Board Diagram

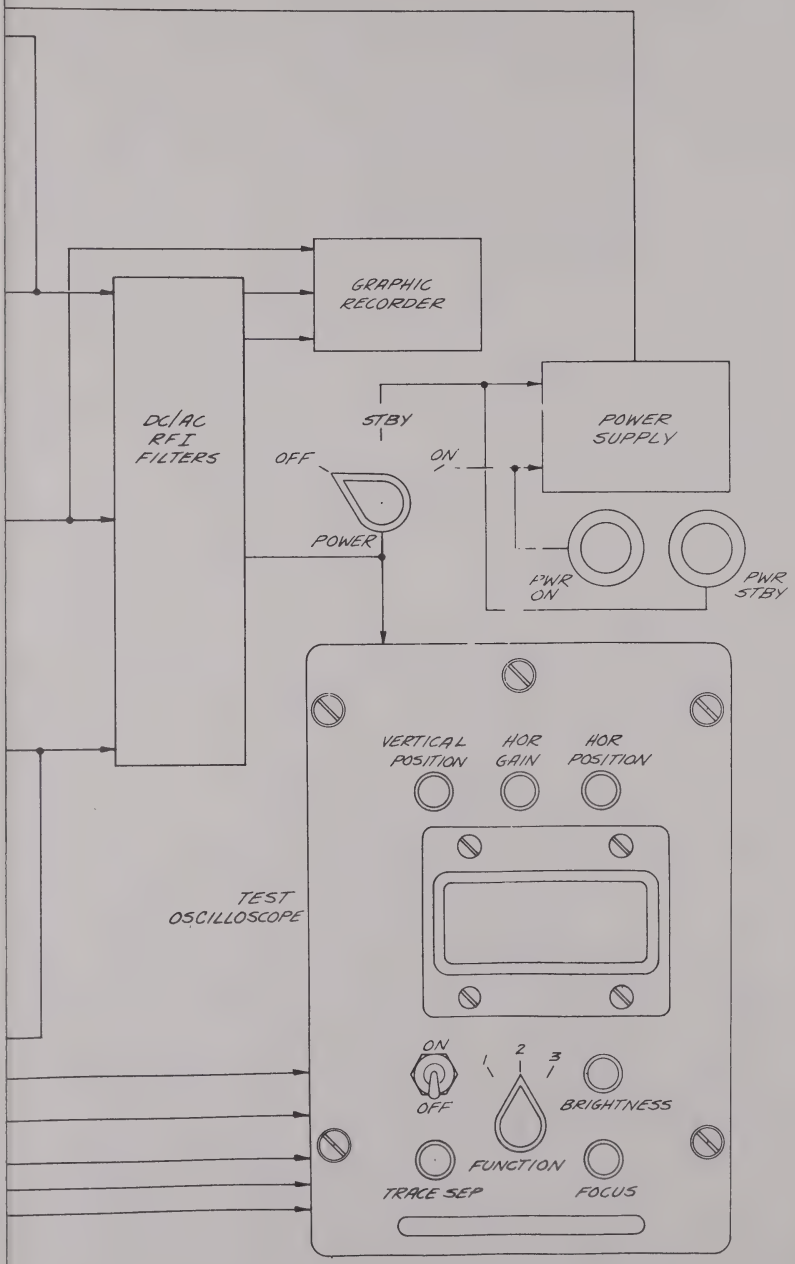
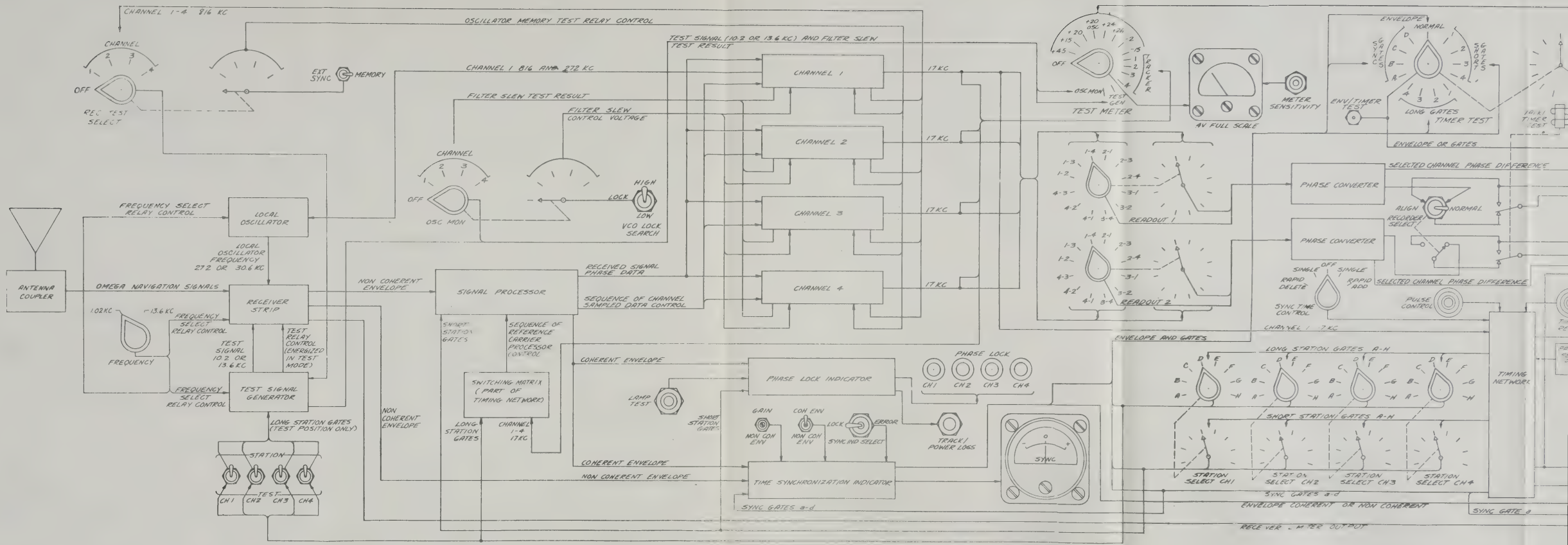


Figure 5-46. Omega Navigation Receiving Set System Functional Block Diagram


CHANNEL 1-4 816 KC
OSCILLATOR MEMORY TEST RELAY CONTROL
CHANNEL
OFF
REC TEST SELECT
EXT SYNC
MEMORY
CHANNEL 1 816 AND 272 KC
FILTER SLEW TEST RESULT
FILTER SLEW CONTROL VOLTAGE
TEST SIGNAL (10.2 OR 13.6 KC) AND FILTER SLEW TEST RESULT
CHANNEL 1
CHANNEL 2
CHANNEL 3
CHANNEL 4
17 KC
HIGH
LOCK
LOW
VCO LOCK SEARCH
OSC MON
FREQUENCY SELECT RELAY CONTROL
LOCAL OSCILLATOR
LOCAL OSCILLATOR FREQUENCY 272 OR 30.6 KC
ANTENNA COUPLER
OMEGA NAVIGATION SIGNALS
RECEIVER STRIP
NON COHERENT ENVELOPE
SIGNAL PROCESSOR
RECEIVED SIGNAL PHASE DATA
SEQUENCE OF CHANNEL SAMPLED DATA CONTROL
10.2 KC
13.6 KC
FREQUENCY
FREQUENCY SELECT RELAY CONTROL
TEST SIGNAL 10.2 OR 13.6 KC
TEST RELAY CONTROL (ENERGIZED IN TEST MODE)
TEST SIGNAL GENERATOR
FREQUENCY SELECT RELAY CONTROL
LONG STATION GATES (TEST POSITION ONLY)
STATION
TEST
CH1 CH2 CH3 CH4
NON COHERENT ENVELOPE
SHORT STATION GATES
SEQUENCE OF REFERENCE CHANNEL PROCESSOR CONTROL
SWITCHING MATRIX (PART OF TIMING NETWORK)
LONG STATION GATES
CHANNEL 1-4 17 KC
COHERENT ENVELOPE
LAMP TEST
PHASE LOCK INDICATOR
PHASE LOCK
CH1 CH2 CH3 CH4
SHORT STATION GATES
GAIN
MON COH ENV
COH ENV
LOCK
ERROR
SYNC IND SELECT
TRACK/ POWER LOSS
COHERENT ENVELOPE
NON COHERENT ENVELOPE
TIME SYNCHRONIZATION INDICATOR
SYNC GATES a-d
SYNC
+20 OSC +24
+15 +20
+10 +15
+5 OFF
OSC MON
TEST GEN
POWER
TEST METER
METER SENSITIVITY
4V FULL SCALE
ENVELOPE
NORMAL
SYNCS
SYNC GATES
ENV/TIMER TEST
LONG GATES
TIMER TEST
ENVELOPE OR GATES
SELECTED CHANNEL PHASE DIFFERENCE
PHASE CONVERTER
PHASE CONVERTER
ALIGN
NORMAL
RECORDER SELECT
SELECTED CHANNEL PHASE DIFFERENCE
READOUT 1
READOUT 2
SINGLE RAPID DELETE
OFF
SINGLE RAPID ADD
SYNC TIME CONTROL
PULSE CONTROL
CHANNEL 1 17 KC
ENVELOPE AND GATES
LONG STATION GATES A-H
SHORT STATION GATES A-H
TIMING NETWORK
STATION SELECT CH1
STATION SELECT CH2
STATION SELECT CH3
STATION SELECT CH4
SYNC GATES a-d
ENVELOPE COHERENT OR NON COHERENT
SYNC GATE a
RECEIVER METER OUTPUT

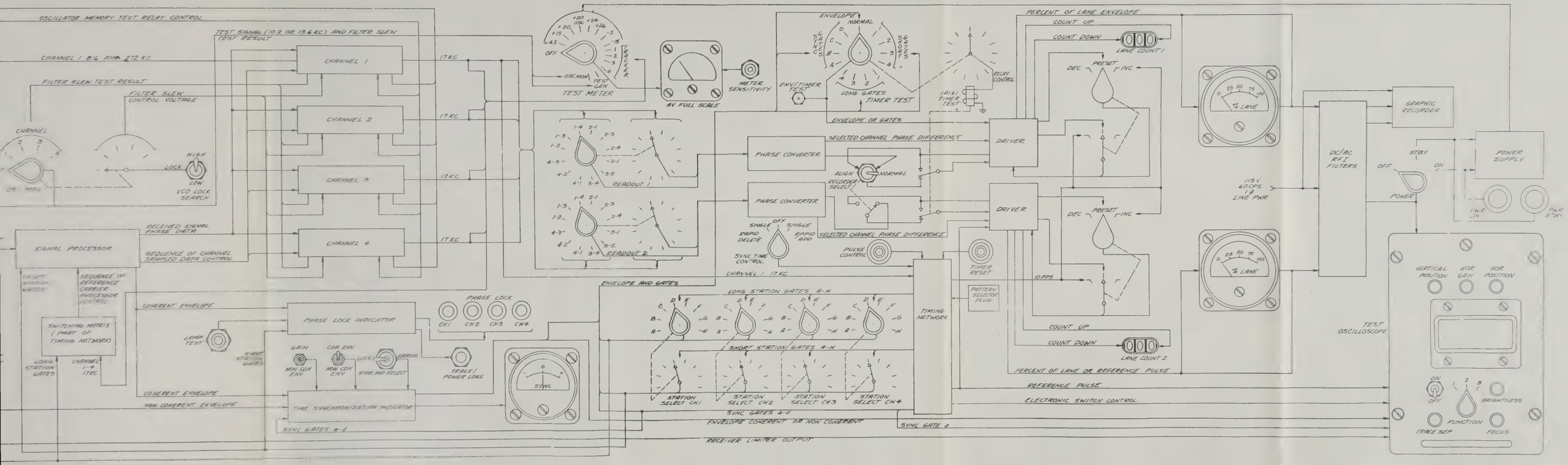
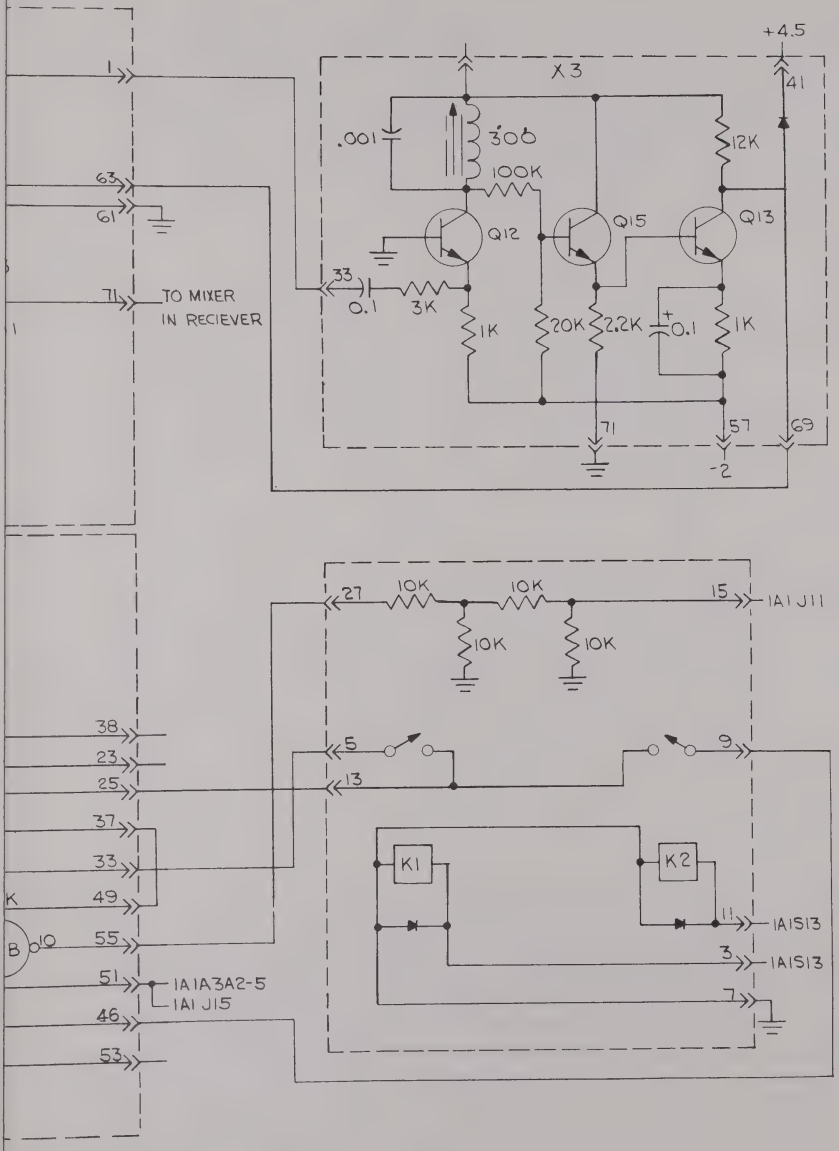


Figure 5-46. Omega Navigation Receiving Set System Functional Block Diagram



gure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 1 of 4 Sheets

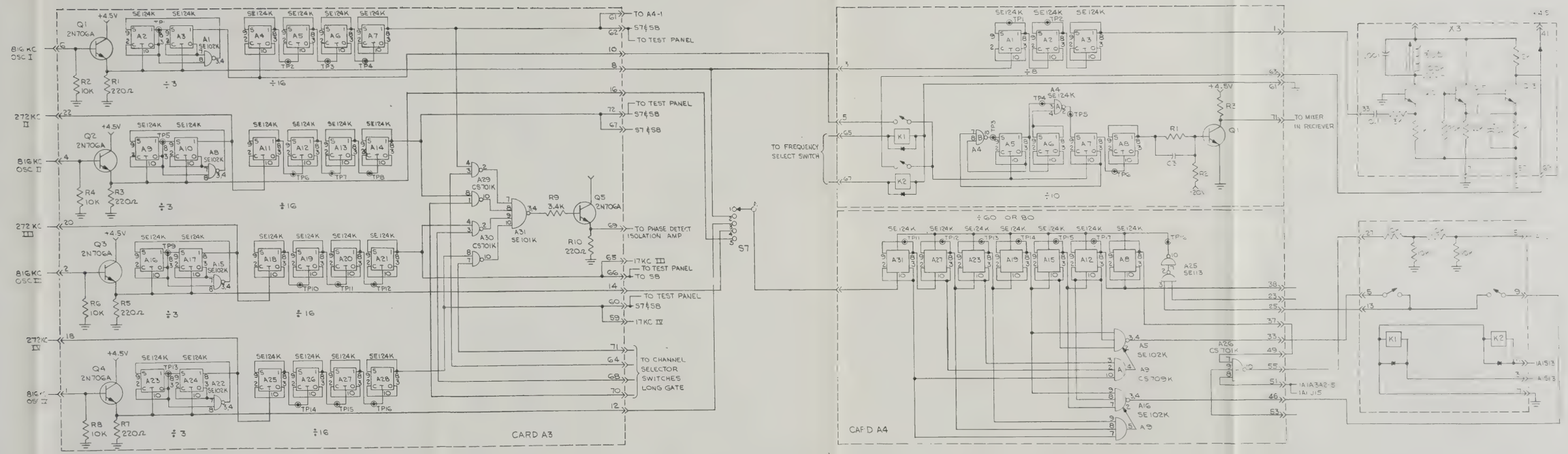


Figure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 1 of 4 Sheets

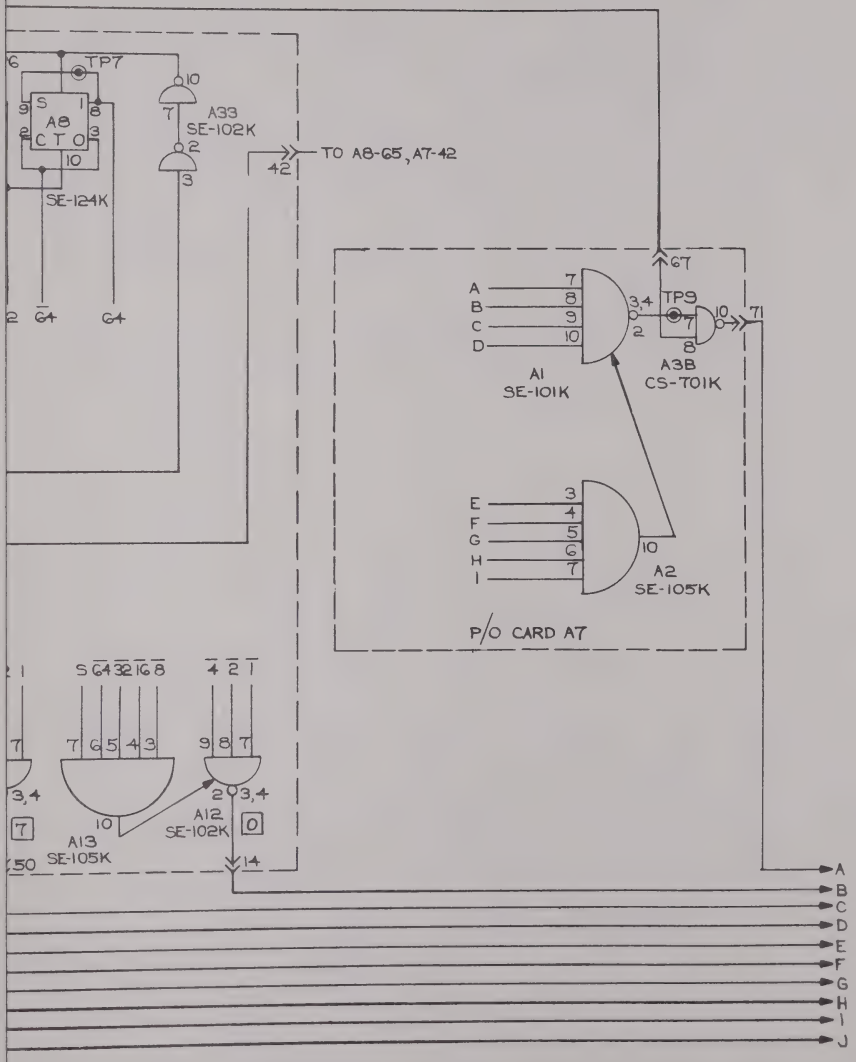


Figure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 2 of 4 Sheets

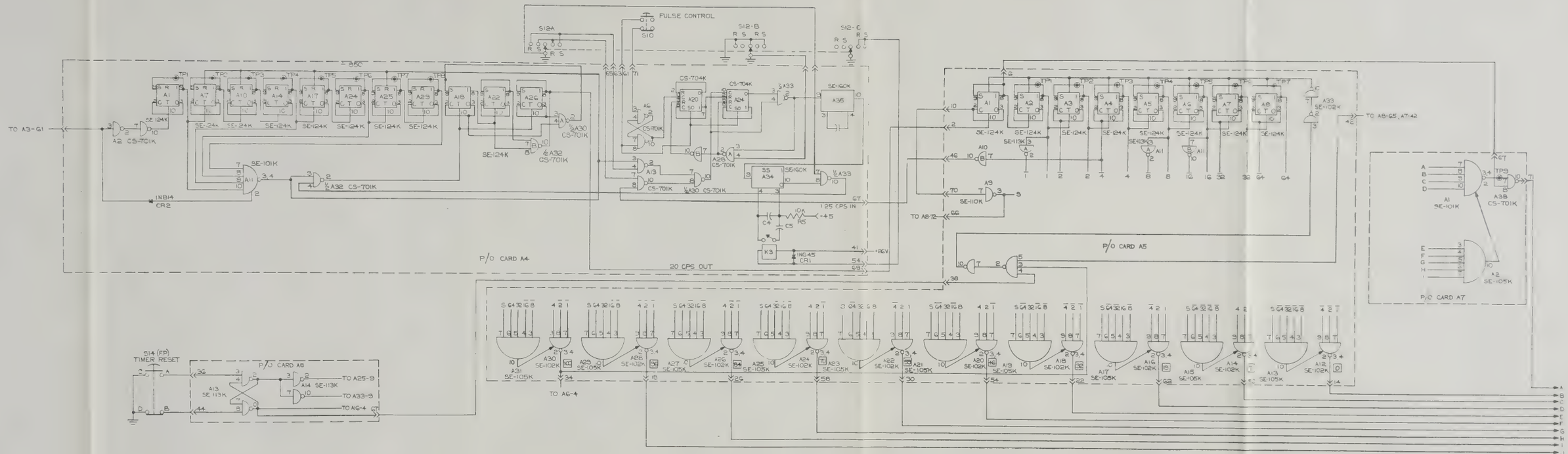
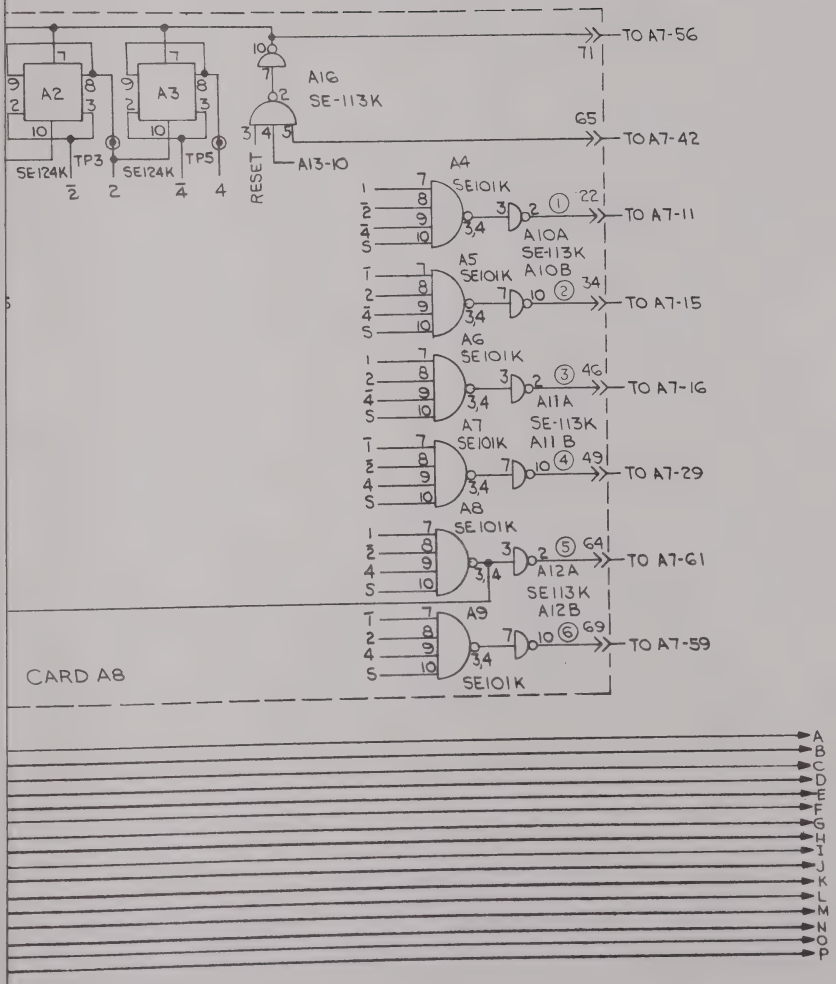


Figure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 2 of 4 Sheets



ure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 3 of 4 Sheets

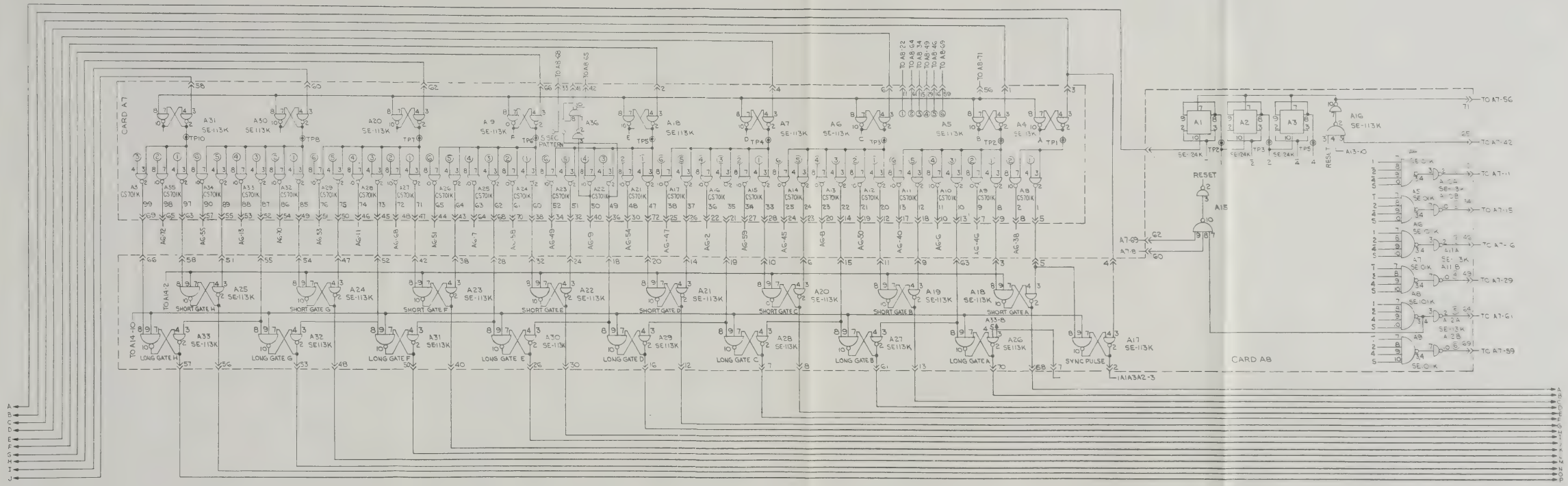
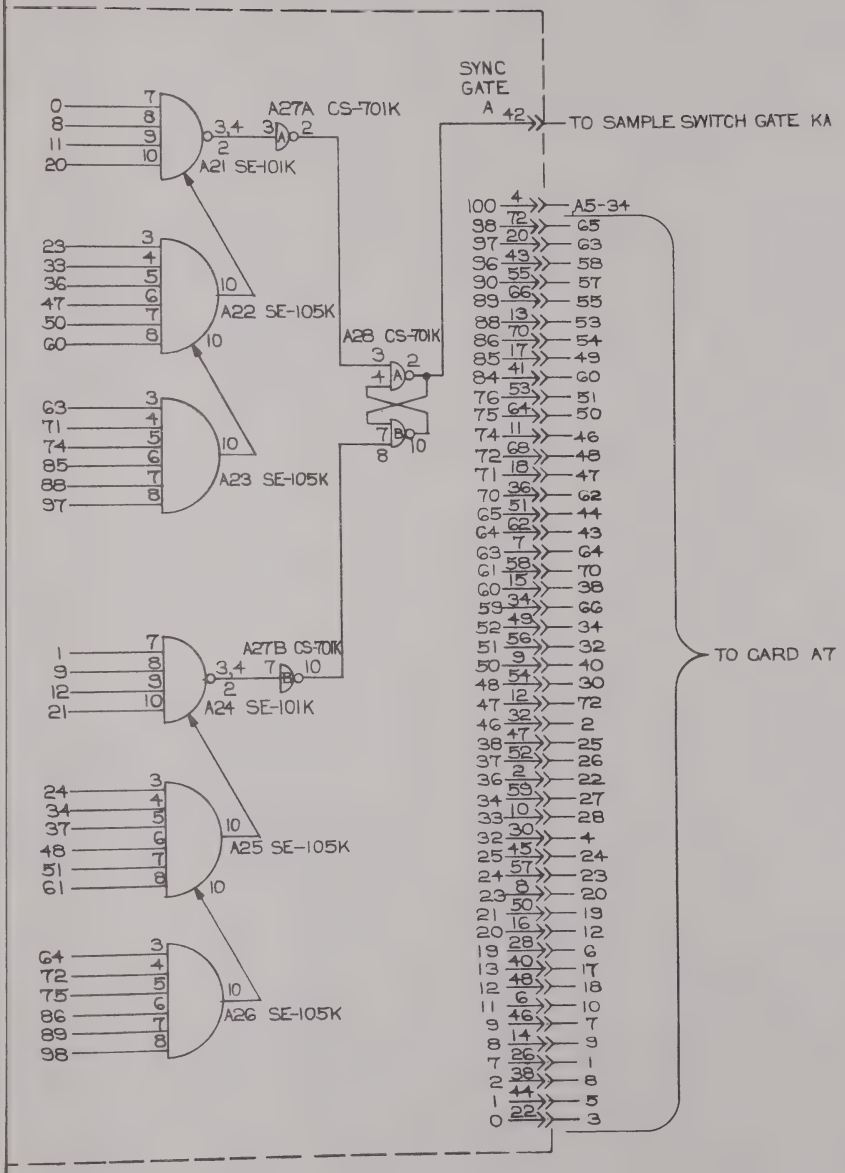
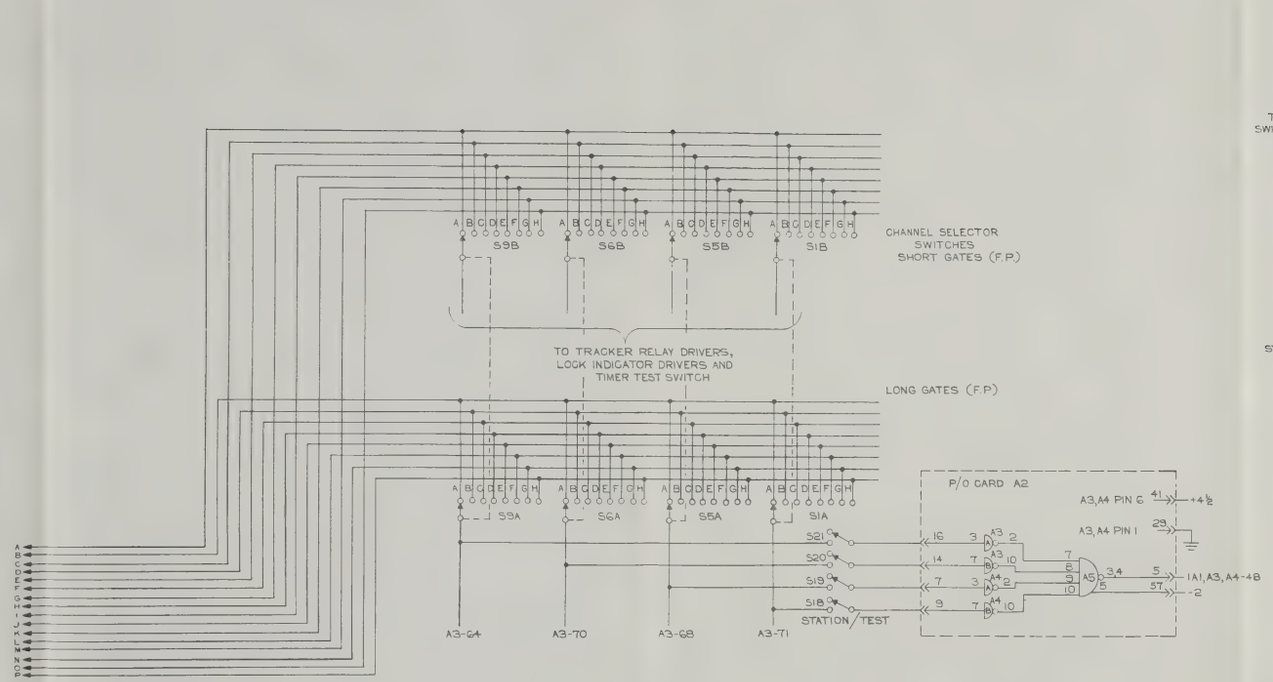


Figure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 3 of 4 Sheets



ure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 4 of 4 Sheets



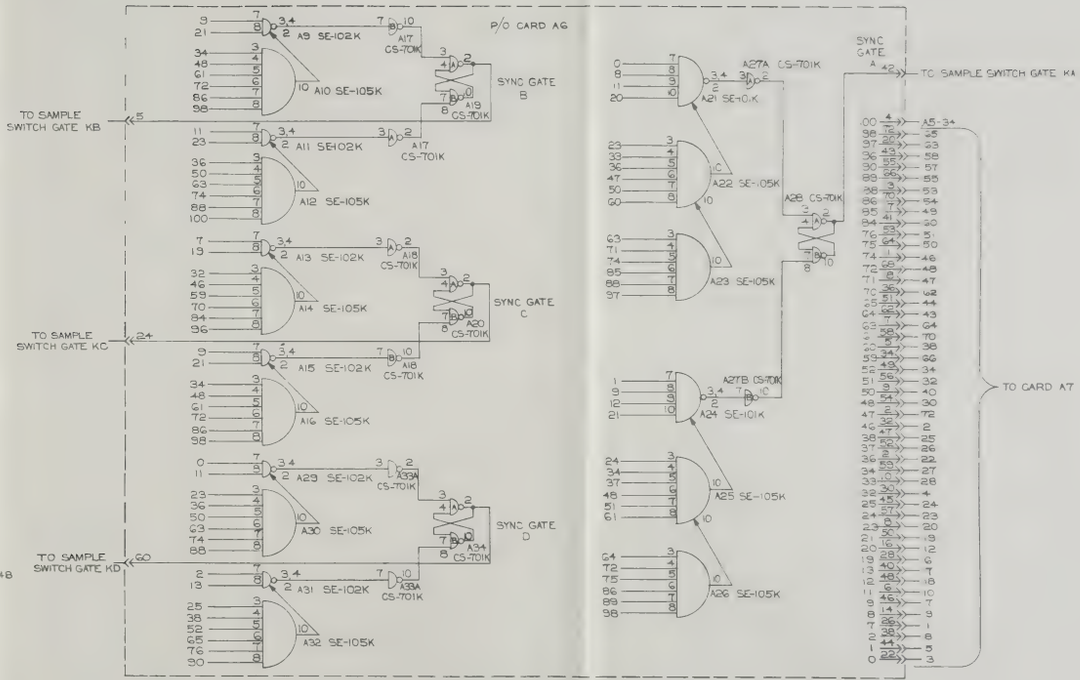


Figure 5-47. Omega Navigation Receiving Set Logic Diagram, Sheet 4 of 4 Sheets

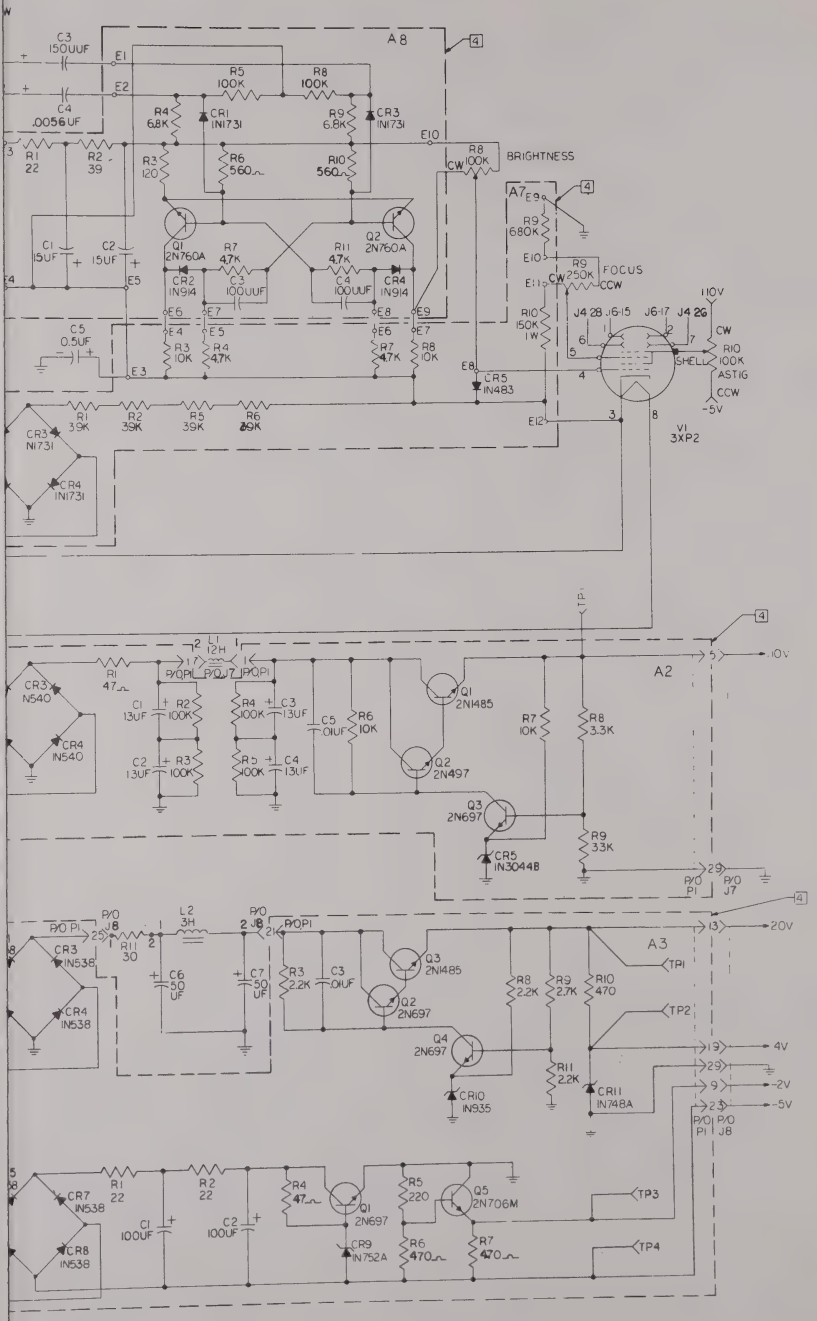


Figure 5-48. Test Oscilloscope Schematic Diagram

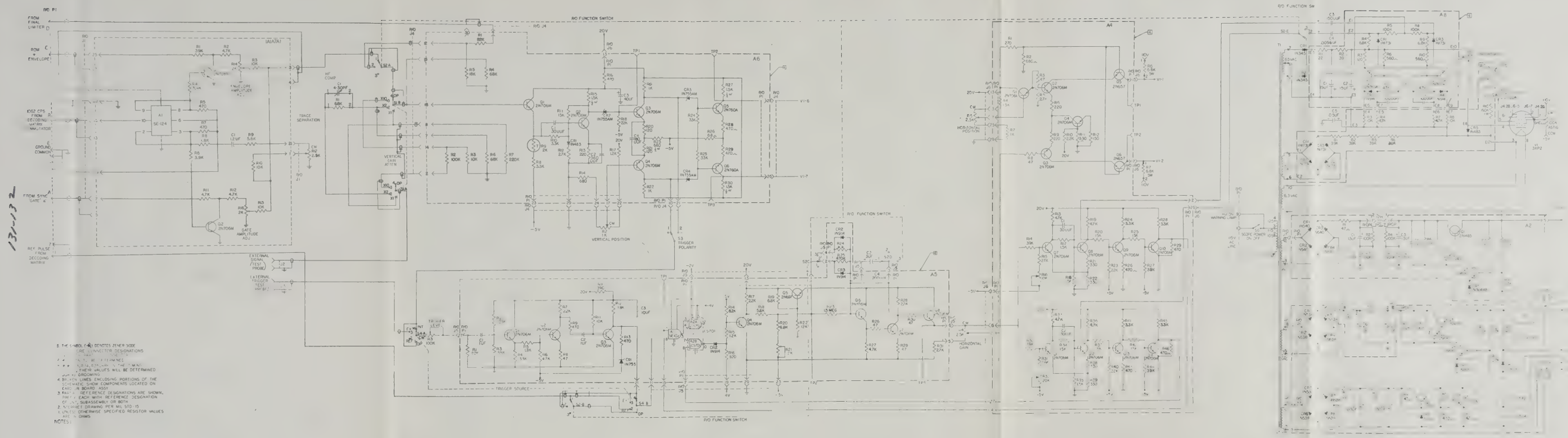
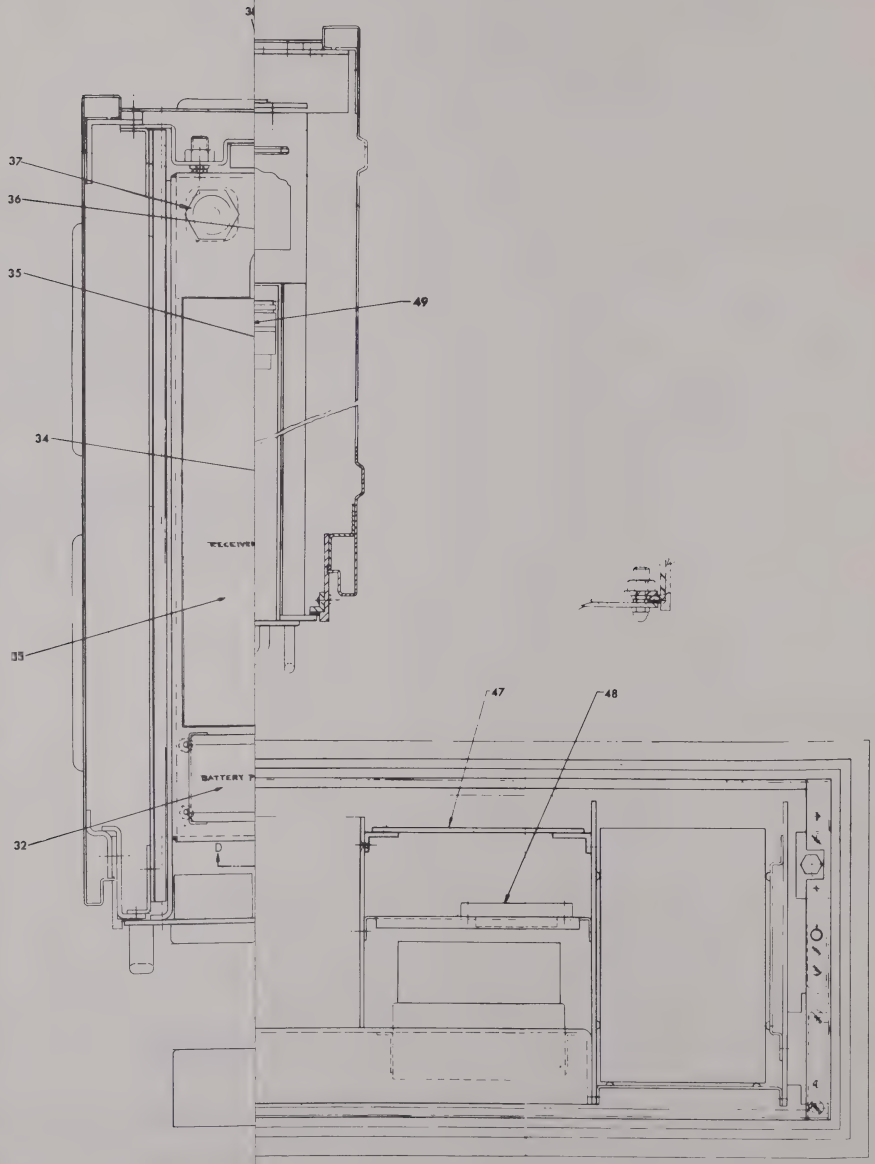


Figure 5-48. Test Oscilloscope Schematic Diagram



Receiver Indicator Assembly Diagram.

ceiver Indicator Assembly Diagram

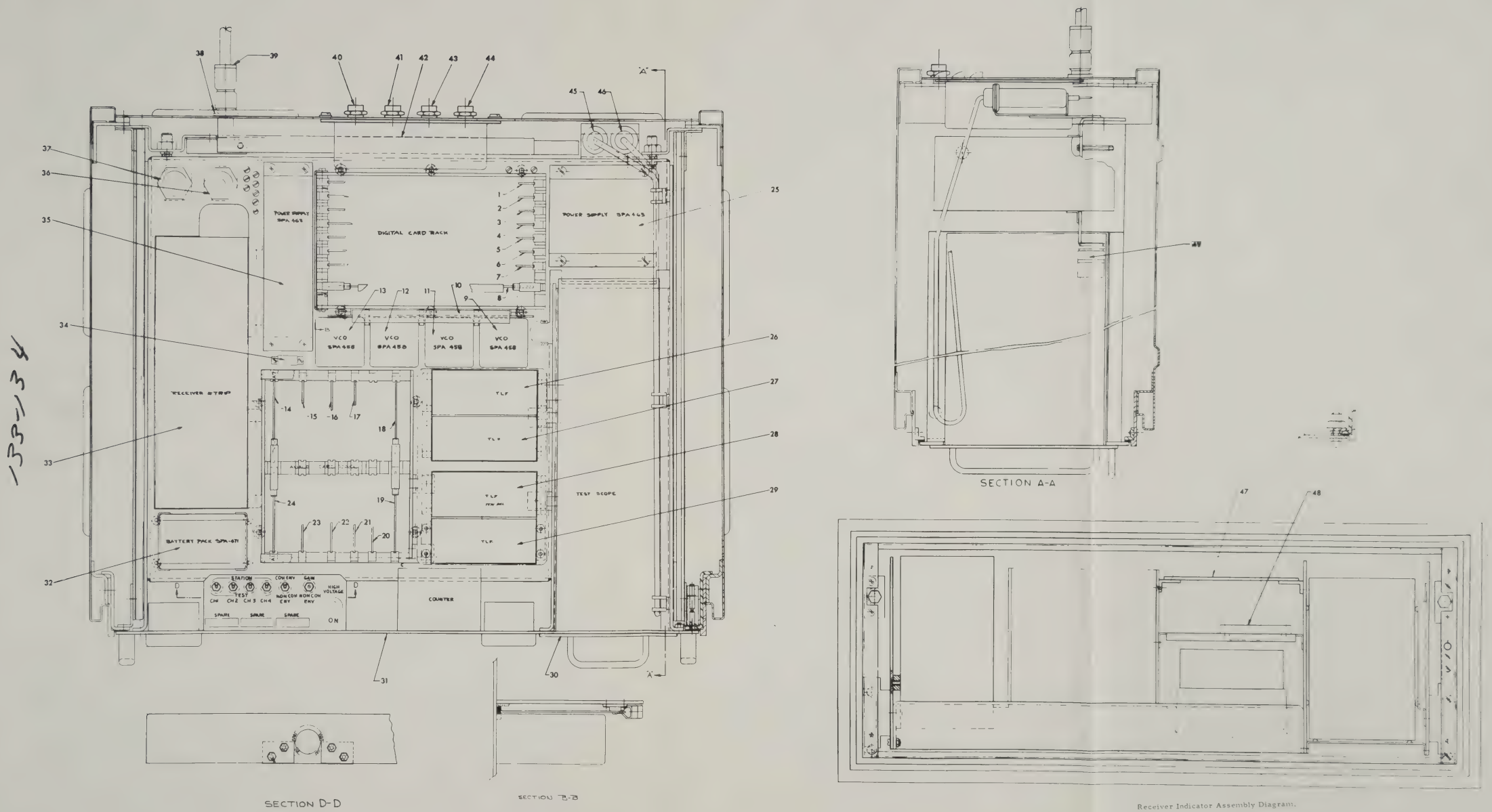


Figure 5-49. Receiver Indicator Assembly Diagram

SECTION 6
PARTS LIST

6-1. INTRODUCTION

a. UNITS OF THE EQUIPMENT -- The units supplied with the Omega Receiver Set are the Receiver, the Antenna Assembly, and the Graphic Recorder. The Graphic Recorder is a standard commercial test instrument. The necessary parts list is presented in the instruction book supplied with the instrument.

b. MAINTENANCE PARTS LIST -- Table 6-1 lists the manufacturers and their code numbers as used in the maintenance parts list. Tables 6-2 through 6-11 are the main assemblies and subassemblies. The Index Number column in the tables indicates the parts locator number found in the assembly drawings in section 6.

6-2. PRINTED CIRCUIT CARD REPLACEMENT

Circuit elements that are normally subject to failure are almost all mounted on printed circuit cards. Repair usually consists of substituting a spare card for one that proves defective. Cards that have become defective are returned to the Manufacturer for evaluation and subsequent repair if feasible.

TABLE 6-1. LIST OF MANUFACTURERS

CODE	NAME	ADDRESS
09922	Burndy Corporation	Norwalk, Connecticut
71744	Chicago Miniature Lamp Works	Chicago, Illinois
83851	Kurman Electric Co. Inc.	Long Island City, N. Y.
14772	Marine Equipment Department, Northrop Nortronics	Needham, Massachusetts
00798	Mutron Corporation	Brockton, Massachusetts
77820	Scintilla Magneto Division of Bendix Aviation Corporation	Sidney, New York
81095	Triad Transformer Corporation	Venice, California
80223	United Transformer Co.	New York, New York

TABLE 6-2. RECEIVING INDICATOR, PART NUMBER 39258
(Figure 5-49)

Index No.	Description
1	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39182G1
2	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39181G1
3	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39180G1
4	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39179G1
5	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39178G1
6	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39177G1
7	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39176G1
8	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39175G1
9	OSCILLATOR: Mfg. 14772, p/n 39280-1
10	CARD EXTENDER: Mfg. 14772, p/n 39183G1
11	Same as 9.
12	Same as 9.
13	Same as 9.
14	CARD ASSEMBLY, Printed Circuit: 1A1A2A7, Mfg. 14772, p/n 39163G1
15	CARD ASSEMBLY, Printed Circuit: 1A1A2A8, Mfg. 14772, p/n 39164G1
16	CARD ASSEMBLY, Printed Circuit: 1A1A2A9, Mfg. 14772, p/n 39165G1
17	CARD EXTENDER, Mfg. 14772, p/n 39184G
18	CARD ASSEMBLY, Printed Circuit: 1A1A2A12, Mfg. 14772, p/n 39166G1
19	CARD ASSEMBLY, Printed Circuit: 1A1A2A6, Mfg. 14772, p/n 39162G1
20	CARD ASSEMBLY, Printed Circuit: 1A1A2A5, Mfg. 14772, p/n 39161G1
21	CARD ASSEMBLY, Printed Circuit: 1A1A2A4, Mfg. 14772, p/n 39160G1
22	CARD ASSEMBLY, Printed Circuit: 1A1A2A3, Mfg. 14772, p/n 39159G1
23	CARD ASSEMBLY, Printed Circuit: 1A1A2A1 and 1A1A2A2, Mfg. 14772, p/n 39158G1
24	CARD ASSEMBLY, Printed Circuit: 1A1A2A1, Mfg. 14772, p/n 39158G1
25	POWER SUPPLY ASSEMBLY: Mfg. 14772, p/n 39319G1
26	FILTER ASSEMBLY, Tracking Loop: Mfg. 14772, p/n LE2126
27	Same as 26.
28	Same as 26.
29	Same as 26.
30	TEST OSCILLOSCOPE ASSEMBLY: See Table 6-4.
31	CONTROL PANEL ASSEMBLY: See Table 6-3.
32	BATTERY PACK: Mfg. 14772, p/n 39282-1

TABLE 6-2. RECEIVING INDICATOR (continued)

Index No.	Description
33	RECEIVER STRIP ASSEMBLY: See Table 6-9.
34	RELAY: Mfg. 83851, p/n KX1H2E-24
35	POWER SUPPLY ASSEMBLY: Mfg. 14772, p/n 39318G1
36	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E16-8P
37	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E14-5PW
38	CONNECTOR, ELECTRICAL: Mil type UG-423B/U
39	CONNECTOR, ELECTRICAL: Mil type UG-544/U
40	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E14-5PY
41	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E14-5SZ
42	R.F.I. FILTER ASSEMBLY: See Table 6-8.
43	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E14-5SY
44	CONNECTOR, ELECTRICAL: Mfg. 77820, p/n MS3114E14-5SW
45	PROBE, SYNCHRONIZATION: Mfg. 00798, p/n 60093
46	PROBE, SIGNAL: Mfg. 00798, p/n 60092
47	TEST PANEL ASSEMBLY: See Table 6-7.
48	WIRING HARNESS ASSEMBLY: Mfg. 14772, p/n 39409G1
49	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39018-2

TABLE 6-3. CONTROL PANEL ASSEMBLY, PART NUMBER 39133
(Figure 5-1)

Index No.	Description
1	LANE COUNTER: Mfg. 14772, p/n 37531-1
2	METER: Mfg. 14772, p/n SPA 489
3	Same as 2.
4	KNOB: Mil type, MS91528-1P2B
5	SWITCH, ROTARY: 1 pole, 8 position, 2 wafer, Mfg. 14772, p/n 39298-1
6	SWITCH, PUSHBUTTON: Mil type MS16712
7	Same as 4.
8	SWITCH, ROTARY: 2 pole, 3 position, 1 wafer; Mfg. 14772, p/n 39303-1
9	LAMP: Type LVN-F24-AL-F2
10	Same as 4.

TABLE 6-3. CONTROL PANEL ASSEMBLY (continued)

Index No.	Description
11	Same as 5.
12	Same as 9.
13	Same as 9.
14	Same as 9.
15	Same as 4.
16	Same as 5.
17	Same as 5.
18	Same as 4.
19	LAMP: type LVB-D24-AA-L2
20	LAMP: Mil type NE-51H
21	Same as 6.
22	LAMP: Mil type NE-51H
23	Same as 4.
24	SWITCH, ROTARY: 3 pole, 3 position, 2 wafer; Mfg. 14772, p/n 39313-1
25	JACK, TELEPHONE: Mil specification MIL-J-641/18, type JJ-134
26	SWITCH, TOGGLE: Mil type MS35058-23
27	METER: Mfg. 14772, p/n SPA 490
28	Same as 4.
29	SWITCH, ROTARY: 2 pole, 2 position, 1 wafer; Mfg. 14772, p/n 39296-1
30	Same as 4.
31	SWITCH, ROTARY: 3 pole, 5 position, 1 wafer; Mfg. 14772, p/n 39302-1
32	SWITCH, TOGGLE: Mil type MS35059-23
33	SWITCH, PUSH: Mil type MS16712
34	SWITCH, ROTARY: 1 pole, 12 position, 2 wafer; Mfg. 14772, p/n 39297-1
35	Same as 4.
36	Same as 34.
37	Same as 4.
38	Same as 1.
39	Same as 7.
40	Same as 8.
41	RESISTOR, FIXED: Mil type RC07601K
42	RESISTOR, FIXED: Mil type RC07203K

TABLE 6-3. CONTROL PANEL ASSEMBLY (continued)

Index No.	Description
43	TERMINAL BOARD: Type 26TB6
44	Same as 43.
45	POTENTIOMETER: 3/8" long shaft, Mil type RV6NAYSD104A
46	LAMP ASSEMBLY: Mil type, LH76LC14RD
47	FUSE: Mil type, MS90078-12-1
48	FUSE: Mil type, MS90078-11-1
49	FUSE: Mil type, MS90078-9-1
50	SWITCH, TOGGLE: type TW2106
51	Same as 50
52	Same as 50
53	Same as 50

TABLE 6-4. TEST OSCILLOSCOPE ASSEMBLY, PART NUMBER 39050
(Figure 5-33)

Index No.	Description
1	TRANSFORMERS: Mfg. 14772, p/n SPA 437
2	CAPACITOR: Mil type, CL 21CK 500 TP3
3	Same as 2.
4	SOCKET TUBE: Mfg. 14772, p/n 39112-1
5	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39171G1
6	JACK: Mil type, UG-253/U
7	RESISTOR, VARIABLE: Mil type, RV6LAYSA104A
8	KNOB: Mil type, MS91528-1P2B
9	SWITCH, ROTARY: p/n 39301-1
10	Same as 6.
11	Same as 8.
12	Same as 9.
13	Same as 7.
14	SWITCH, TOGGLE: type TW2106
15	CAPACITOR: Mfg. 14772, p/n 39098-1
16	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39174G1
17	CAPACITOR: Mil type, p/n CV11D300

TABLE 6-4. TEST OSCILLOSCOPE ASSEMBLY (continued)

Index No.	Description
18	RESISTOR, FIXED: Mil std p/n RC20683K
19	SHIELD, TUBE: Mfg. 14772, p/n 37601-1
20	TUBE, CATHODE RAY: JAN type 3XP2
21	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39173G1
22	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39172G1
23	CARD ASSEMBLY, Printed Circuit: No. 1A1A7A1, Mfg. 14772, p/n 39169G1
24	CARD ASSEMBLY, Printed Circuit: Mfg. 14772, p/n 39170G1
25	RESISTOR, FIXED: Mil type, RW55G300J
26	CHOKE: Mfg. 14772, p/n 39048-1
27	KNOB: Mil type MS91528-ONIB
28	RESISTOR, VARIABLE: Mil type RV6NAYSD254A
29	Same as 27.
30	Same as 28.
31	Same as 27.
32	RESISTOR, VARIABLE: Mil type RV6NAYSD102A
33	Same as 27.
34	RESISTOR, VARIABLE: Mil type RV6NAYSD254A
35	Same as 8.
36	SWITCH, ROTARY: Mfg. 14772, p/n 39212-1
37	Same as 27.
38	Same as 28.
39	Same as 14.
40	Same as 27.
41	RESISTOR, VARIABLE: Mil type RV6NAYSD102A
42	RESISTOR, FIXED: Mil type RW55G682
43	Same as 42.
44	DIODE: Mil type IN1124AM
45	CHOKE: Mfr 81095, p/n HS-339
46	CAPACITOR: Mil type CM45B102J03
47	CAPACITOR: Mil type CP12AIKG562K3
48	CAPACITOR: Mil type CP72E1EJ504K1

TABLE 6-5. COMPONENT BOARD 1A1A7A8
(Figure 5-35)

Index No.	Description
1	DIODE: Mil type 1N914
2	Same as 1.
3	CAPACITOR: Mil type CM15C101J03
4	RESISTOR, FIXED: Mil type RC20GF472K
5	DIODE: Mil type 1N1731
6	RESISTOR, FIXED: Mil type RC07GF682K
7	RESISTOR, FIXED: Mil type RC07G104K
8	Same as 7.
9	CAPACITOR: Mil type CL44BL150MP3
10	Same as 9.
11	RESISTOR, FIXED: Mil type RC32GF390K
12	RESISTOR, FIXED: Mil type RC32GF220K
13	Same as 5.
14	RESISTOR, FIXED: Mil type RC07GF121K
15	RESISTOR, FIXED: Mil type RC07GF561K
16	Same as 15.
17	Same as 5.
18	TRANSISTOR: Mil type 2N760A
19	Same as 3.
20	Same as 4.
21	Same as 18.

TABLE 6-6. COMPONENT BOARD 1A1A7A7
(Figure 5-34)

Index No.	Description
1	RESISTOR, FIXED: Mil type RN75B1503F
2	DIODE: Mil type 1N483
3	RESISTOR, FIXED: Mil type RC20GF103K
4	RESISTOR, FIXED: Mil type RC20GF472K
5	Same as 4.
6	Same as 3.

TABLE 6-6. COMPONENT BOARD 1A1A7A7 (continued)

Index No.	Description
7	DIODE: Mil type 1N1731
8	Same as 7.
9	Same as 7.
10	Same as 7.
11	RESISTOR, FIXED: Mil type RC32GF393K
12	RESISTOR, FIXED: Mil type RN80B6803F
13	Same as 11.
14	Same as 11.
15	Same as 11.

TABLE 6-7. TEST PANEL ASSEMBLY
(Figure 5-30)

Index No.	Description
1	SWITCH, ROTARY: 2 pole, 5 position, Mfg. 14772, p/n 39304-1
2	KNOB, CONTROL: Mil type MS91528-1P2B
3	SWITCH, TOGGLE: type TW2106
4	SWITCH, TOGGLE: Mil type MS35058-18
5	Same as 2.
6	Same as 2.
7	Same as 1, p/n 39300-1
8	JACK: Mil type MS16108-2A
9	SWITCH, ROTARY: 1 pole, 15 position, Mfg. 14772, p/n 39314-1
10	Same as 2.
11	METER: Mfg. 14772, p/n SPA 466
12	SWITCH, PUSHBUTTON: Mil type MS16712
13	CAPACITOR: Mil type CM35D512JN3
14	CONNECTOR: Mfg. 14772, p/n 39024-1
15	Same as 14.
16	CONNECTOR: type MS-P-75, Mfg. 14772, p/n 39399-1
17	CARD ASSEMBLY, Printed Circuit: 1A1A4A1; Mfg. 14772, p/n 39167
18	CARD ASSEMBLY, Printed Circuit: 1A1A4A2; Mfg. 14772, p/n 39168
19	SWITCH, ROTARY: 13 position; Mfg. 14772, p/n 39299-1

TABLE 6-8. R. F. I. FILTER ASSEMBLY
(Figure 5-44)

Index No.	Description
1	FILTER UNIT: Mfg. 14772, p/n SPA 456
2	Same as 1.
3	Same as 1.
4	Same as 1.

TABLE 6-9. RECEIVER STRIP ASSEMBLY, PART NUMBER 39265
(Figure 5-2)

Index No.	Description
1	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39307-1
2	CONNECTOR, ELECTRICAL: type UG-447/U
3	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G8
4	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G7
5	CAPACITOR: Mil type CL65BK200MP3
6	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G6
7	Same as 5.
8	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G5
9	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G4
10	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G3
11	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G2
12	Same as 5.
13	Same as 2.
14	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39273G1
15	Same as 2.
16	CONNECTOR, ELECTRICAL: Mfg. 14772, p/n 39400-1
17	Same as 2.
18	Same as 5.
19	Same as 5.
20	Same as 5.
21	Same as 5.
22	Same as 2.
23	RESISTOR, FIXED: Mil type RC07GF822K

TABLE 6-9. RECEIVER STRIP ASSEMBLY (continued)

Index No.	Description
24	RESISTOR, FIXED: Mil type RC07GF102K
25	Same as 2.
26	Same as 23.
27	Same as 24.
28	RESISTOR, FIXED:
29	CARD ASSEMBLY, Printed Circuit: input amplifier 1A1A1A8; Mfg. 14772, p/n 39157G1
30	CARD ASSEMBLY, Printed Circuit: first 10.2 - 13.6 filter 1A1A1A7; Mfg. 14772, p/n 39156G1
31	CARD ASSEMBLY, Printed Circuit: second 10.2 - 13.6 filter 1A1A1A6; Mfg. 14772, p/n 39155G1
32	CARD ASSEMBLY, Printed Circuit: third 10.2 - 13.6 filter 1A1A1A5; Mfg. 14772, p/n 39154G1
33	CARD ASSEMBLY, Printed Circuit: mixer amplifier 1A1A1A4; Mfg. 14772, p/n 39153G1
34	CARD ASSEMBLY, Printed Circuit: first I.F. limiter 1A1A1A3; Mfg. 14772, p/n 39152G1
35	CARD ASSEMBLY, Printed Circuit: 100 cycle filter 1A1A1A2; Mfg. 14772, p/n 39151G1
36	INDUCTOR: Mfg. 80223, p/n MQE-5
37	CARD ASSEMBLY, Printed Circuit: second I.F. limiter 1A1A1A1; Mfg. 14772, p/n 39150G1
38	INDUCTOR: Mfg. 80223, p/n MQE-7
39	Same as 36.
40	Same as 36.
41	Same as 38.
42	Same as 38.
43	Same as 38.

TABLE 6-10. RELAY DRIVER ASSEMBLY
(Figure 5-3)

Index No.	Description
1	TRANSISTOR: Mil type 2N697
2	Same as 1.
3	RESISTOR, FIXED: Mil type RC07GF153K
4	RESISTOR, FIXED: Mil type RC07GF222K
5	RESISTOR, FIXED: Mil type RC07GF393K
6	RESISTOR, FIXED: Mil type RC20GF102K
7	Same as 6.

TABLE 6-11. ANTENNA ASSEMBLY COMPONENT BOARD
(Figure 5-45)

Index No.	Description
1	CAPACITOR: Mfg. 14772, p/n 39073-21
2	LAMP, NEON: Mfg. 71744, type NE-2
3	CAPACITOR: Mfg. 14772, p/n 39073-20
4	INDUCTOR: Mfg. 14772, p/n SPA 483
5	Same as 4.
6	Same as 4.
7	TRANSFORMER: Mfg. 14772, p/n SPA 474

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